FBIS-UST-96-003
2 February 1996

546-2081-96
528 copies
13 Feb 96

Foreign Broadcast Information Service

FBIS Report

Science & Technology

Central Eurasia

Russian State Program for Development of Electronics Technology

ATTENTION!! ATTENTION!! ATTENTION!!

FBIS will phase out publication of most of its paper reports, including ALL Daily Reports and most FBIS Reports, by 31 December 1996.

See inside for information on how to access FBIS products and services electronically.

January 1996

Dear Customer:

Responding to our many customers' requests, NTIS will be offering FBIS publications electronically. Due to resource limitations, hardcopy production of FBIS publications will be phased out during 1996. We will notify our customers well in advance of the expiration date for each of our publications. Please see below regarding electronic access to products.

Our goal is to cease publication of all reports by 31 December 1996, except for S&T PERSPECTIVES, S&T CENTRAL EURASIA, S&T CHINA, S&T KOREA, S&T EUROPE, and S&T JAPAN. The S&T reports will continue to be published as hardcopy until the graphics they contain can be disseminated on-line.

FBIS products are offered electronically through the National Technical Information Service's (NTIS) "World News Connection" (WNC). This is a new on-line subscription service accessible through the World Wide Web. The Web address is http://wnc.fedworld.gov. Please see next page for a subscription form or call NTIS Fax Direct at 703-487-4140 and enter product code 8645 to receive more information.

World News Connection - WNC1	**$ 21**
7 Day - Introductory Offer Unlimited interactive searching [no profiles] **Order number SUB-9856BDQ**	
World News Connection - WNC2	**$ 50**
Monthly Unlimited interactive searching [no profiles] **Order number PB95-985700BDQ**	
World News Connection - WNC3	**$ 75**
Monthly Unlimited interactive searching [1 profile] **Order number PB95-985800BDQ**	
World News Connection - WNC4	**$100**
Monthly Unlimited interactive searching [up to 5 profiles] **Order number PB95-985900BDQ**	

(Prices are subject to change)

World News Connection™

A Foreign News Alert Service from the U.S. Government

User Name *(Please Print or Type)*	**Internet E-mail Address** *(Required)*	**Order Number**	**Price**
1) ______	______	______	______
2) ______	______	______	______

(Continue on a blank sheet if more space is required)

Deposit Account Number (for NTIS account customers only): ______

Customer Master Number (if known): ______ Date: ______

Contact Name: ______ Organization: ______

Street Address: ______ City: ______ State: ______ Zip: ______

Province/Territory: ______ Country: ______

Foreign Postal Code: ______

Internet E-mail Address (Organization contact person): ______

Telephone Number: (   ) ______ Fax Number: (   ) ______

Credit Card Number: ______

Credit Card Expiration Date: ______

Card Type (Visa, Master Card, or American Express): ______

Cardholder's Name (as printed on the credit card): ______

Cardholder's Signature (required to validate all orders): ______

(Please fax this form back to NTIS at **703-321-8547**. Fax service is available 24 hours a day, 7 days a week. To verify receipt of your fax, call (703) 487-4679 between 7:00am - 5:00pm, Monday - Friday, Eastern Time.)

Science & Technology

Central Eurasia

Russian State Program for Development of Electronics Technology

FBIS-UST-96-003 | 2 February 1996

CONTENTS

Russian State Program for Development of Electronics Technology *[Unsigned; Moscow ELEKTRONNAYA PROMYSHLENNOST, Jan 1994]* 1
- Resolution No 453 of the Government of the Russian Federation Dated 6 May 1994, Moscow 1
- Russian State Program for Developing Electronic Equipment: Branch Strategy and Tactics 1
- Electronics Branch and Russian Military Doctrine 9
- Basic Submicron Technologies — Present and Future of Microelectronics 13
- Project. Development of Infrastructure of Complex of Microelectronics Production Facilities 17
- Project. Production of Functionally Complex Integrated Circuits 18
- Project. Production of Functionally Complex Integrated Circuits 18
- Project. Construction of Buildings for Clean Production Processes 19
- Project. Development of CADS Software for Special-Order IS in Open Standards 20
- Project. Development of High-Precision Technology for Plasmochemical Etching and Stimulated Processings at Cryogenic Temperatures 21
- New Generation of Electronic Equipment Items for Extremal Operating Conditions 23
- Microwave Electronics — High Scientific Input and High-Technology Branch of Electronics Technology 25
- Project. Development of New Generation of Powerful Low-Voltage Amplifying Klystrons, Traveling Wave Tubes and Gyrotrons 29
- Project. Development and Organization of Production of Widely Applicable Monolithic Integrated Instruments, Single- and Multifunctional Microwave Microcircuits 30
- Project. Powerful Microwave Instruments and Standardized Energy Sources for General Industrial and Economic Use 31
- Project. Development Work and Standard Production of Mobile Radio Relay Stations for Reporter Operationally Deployable Communication Lines 32
- Project. Development Work and Standard Production of Digital Radio Relay communication Stations Operating in Ranges 3.6-38 GHz. 32
- Project. Development Work and Standard Production of Modern Radio Relay and Surface Satellite Stations Operating in Frequency Ranges 1.5-90 GHz 33
- Project. Development Work and Standard Production of Digital Data Transmission Stations in Frequency Range 92-95 GHz 34
- Project. Development of Equipment for Reception of Signals of Satellite Television and Air-Cable Information Networks 34
- Project. Development Work and Practical Production of TV Journalist Direct Transmission Equipment 34
- Project. Development Work and Standard Production of Personal and Automobile Multichannel Radio Stations 35
- Project. Development Work and Standard Production of Cordless Telephone and Radio Telephone Systems 35
- Project. Development of Production and Manufacture of Modern Models of Electronic Hearing Aids and Components for Them 36
- Project. Development of Equipment and Low-Waste Energy-Conserving Technologies for Processing Wood and Other Construction Materials 37
- Project. Further Development and Organization of Large-Scale Production of Microwave Ovens for Household and Industrial Purposes 38
- Project. Research on Influence of Electromagnetic Waves in Millimeter Range on Biological Objects and Development of Biomedical Equipment 39
- Project. Radar System for Navigational Support of Ship Berthing 39
- Project. System for Controlled Slowing of Railroad Cars When Breaking Up Trains on Classification Hump and System for Control of Electric Propulsion Motors of Locomotives on Basis if Radar Speed Sensors Operating in Millimeter Range 40

Project. Development of Radar Sensors in Millimeter Range for Preventing Automobile Collisions 40
Project. Development of Equipment and Technologic Production Processes for Food and Processing Branches of Agroindustrial Complex 41
Project. Development of Microwave Equipment and Technologies for Many-Sided Processing of Hydrobionts and Production of Food and Fodder Fish Products 42
Semiconductor Electronics — Generator of Technical and Economic Progress 43
Project. Development and Production of Low-Noise and Powerful Gallium Arsenide Microwave and EHF Transistors for Highly Informative Communication Systems 46
Project. Development and Production of Powerful Silicon Field Transistors Operating in Microwave Range for Radar, Navigation, Telemetry, Medicine and Communication 47
Project. Standard Production of Microwave Mixing Diodes Operating in 2-cm Range 47
Project. Standard Production of Microwave Low-Noise Mixing Diodes 48
Project. Standard Production of Microwave Mixing Diodes With Three- Dimensional Potential Barriers 48
Project. Development and Production of Powerful Microwave Switching Diodes 49
Project. Creation of Discrete and Combined Ultrastable Certified Precision Stabistors 49
Project. Development and Production of Integrated Precision Stabistor and Reference Voltage Sources 50
Project. Development and Production of High-Quality Varicaps 50
Project. Development of Photodetectors Based on Charge-Coupled Instruments for Special Television Information Systems 51
Project. Development of High-Temperature and High-Voltage Semiconductor Diodes 52
Project. Development and Production of Powerful Silicon Switching Transistors for Power Electronics 53
Project. Hybrid Functional Power Modules 54
Project. Pulsed Switching and Protective Gas-Discharge Instruments 54
Optoelectronic Instruments for Optical Reception, Processing, Transmission and Display of Information 55
Project. Standard Production of Wide Variety of Optoelectronic Instruments 57
Project. Standard Production of Emitting and Photodetecting Diodes Operating in IR Range 57
Project. Development of Highly Efficient Semiconductor Indicators and Display Systems 58
Project. Development of Highly Efficient Silicon Carbide Light-Emitting Diodes 59
Information Display Instruments 59
Project. Dual-Purpose Flat Information Screens and Intellectual Consumer Goods Based on Them 61
Project. Organization of Production of Flat TV Screens for Pocket Color TV Sets, Personal Computers and Special Use 62
Project. Organization of Production of TV Sets With Flat Liquid-Crystal Screen 62
Project. Development and Organization of Production of Flat Information Screens With Matrix Autoemission Cathode 63
Project. Development and Organization of Production of Television Receivers With Flat Passive-Matrix Liquid-Crystal Screen (PMLCS) 64
Project. Development and Standard Production of Large TV Screens Based on Gas-Discharge Indicator Panels (GDIP) 64
Project. Development of New Types of Color Kinescopes, Deflecting Systems, Equipment and Materials for Them 66
Project. Basic Modules for Monochromatic and Color Kinescopes With Combined Design 67
Project. Development and Introduction Into Standard Production of Video Projection System With Luminescent Screen for Individual (Household TV) and Group (Office, Auditorium, etc.) Use 67

Project. Airborne Color Electronic Instruments and Display Kinescopes for Civil Aviation ... 67
Project. Development of Laser TVF Projector Based on Laser Cathode-Ray Tube for Collective-Use Screens ... 68
Project. Development and Startup of Production of Multifrequency Resolution Video Projector ... 69
Project. Development and Startup of Production of Video Projection System With Doubled Light Flux ... 70
Project. Development of Projection-Type Monitor With Luminescent Screen and Its Introduction Into Production ... 70
Project. Developing Video Projector Based on Active Liquid Crystal Matrix and Putting It Into Production ... 71
Project. Development of Technology for Large-Series Production of Antiglare Protective Filters for Personal Computer Monitors ... 72
Project. Development, Manufacture of Experimental Consignment and Organization of Production of X-Ray-Television Complex Based on High- Resolution X-ray Vidicons ... 72
Photoelectronics During 1995-1997 ... 73
Image Converters for Night Vision Instruments ... 76
Project. Image Converter of Generation 2^+ and 2^+ Super ... 78
Project. Universal Night Vision Glasses ... 79
Project. "Electronic Eye" TV Camera ... 79
Project. Camera for Remote Monitoring of Radiation Contamination of Terrain ... 80
Project. Infrared Microscope ... 80
Project. Plane X-Ray Image Brightness Amplifier ... 81
Project. X-Ray Image Brightness Amplifiers ... 81
Project. Gamma Camera for Diagnostic Purposes ... 82
Project. Tomographic Gamma Camera for Diagnostic Purposes ... 83
Project. X-Ray Television Microscope ... 83
Project. Low-Dose Medical Fluorograph ... 84
Quantum Electronics. Prospects for Development ... 84
Project: New Radiation Sources ... 85
Project. Semiconductor Laser Diodes Operating in Blue and UV Radiation Ranges 86
Project. Set of Measuring Navigational Systems Based on Annular Lasers for Conducting Underground Work ... 87
Project. Self-Contained Gyroscopic Navigation System ... 87
Modern Directions in Development of Piezotechnology ... 88
Project. Development of Designs and Organization of Production of Piezoelectric Filters ... 90
Project. Development of Designs and Organization of Production of Piezoelectric Resonators ... 90
Project. Development of Basic Technologies and Large-Scale Production of Quartz Resonators and Quartz Oscillators ... 91
Project. Development of Designs and Organization of Production of Surface Acoustic Wave Filters ... 91
Project. Development of Designs and Organization of Production of Quartz Oscillators With Frequency Temperature Compensation (TC) for FAPSI Equipment and High-Frequency FM Quartz Oscillators With Powerful Output ... 92
Project. Development of Designs and Organization of Production of Piezoresonance Transducers and Equipment Based on Them ... 92
Radio Parts and Radio Components ... 93
Switching Devices ... 94
Project. Variable Nonwire Resistors ... 96
Project. High-Frequency, High-Voltage Polarized Vacuum Relays ... 97
Project. High-Frequency High-Voltage Unpolarized Vacuum Relays ... 97
Project. Galvanotechnology ... 98
Project. Push-button Switches Protected Against Dust and Spray ... 99

Project. Push-button Switches With Light Indication Protected Against Dust and Spray 99
Project. Push-button Switches With Increased Reliability 99
Project. Push-button Switches With Light Indication 100
Project. DIP Switches 100
Project. Sealed Switches 101
Project. Sources of Secondary Electric Power 101
Project. Power Transformers 102
Project. Fuses 102
Project. Multiple-Action Fuses 103
Project. Data Input Device 103
Project. Protected Keyboard 103
Project. Microprocessor Microohmmeter 104
Project. Production of Wide-Purpose Sealed Contact Assemblies 104
Basic and Practical Research in Highly Important Electronic Technology Fields 105
Synchrotron as Experimental and Technological Basis for Conducting Basic and Practical Research in Micro- and Nanoelectronics 107
Project. Use of Synchrotron Radiation in Microelectronics. Establishing a Synchrotron-Based Scientific-Production Facility 115
Foundation for Development of Electronics Technology — Exceptionally Pure Materials 116
Project. Monosilane 117
Project. Filters 117
Project. A^3B^5 Plates and Monocrystals 118
Project. Exceptionally Pure Reagents 118
Project. Monocrystalline Silicon 119
Project. Sealing Materials 119
Project. Liquid Crystal Materials 120
Project. Photoresists 121
Project. Targets 122
Project. Graphite 122
Project. Silicon Carbide 123
Project. Blanks for Phototemplates 124
Project. Abrasive Materials 125
Project. Diffuse Silicon Structures 125
Project. Silicon Plates 126
Project. Solar Power Plants (SPP) 127
Equipment for Production of Electronic Equipment Items 128
Project. Development of Technologic Equipment Complexes for Production of LSI and VLSI Chips 130
Project. Development of High-Precision Lithographic and Control Equipment Outfit 132
Project. Development of Technology and Equipment for High-Voltage Ion Implantation 132
Project. New Generation of Vacuum Gages and Mass Spectrometers 133
Project. Test Equipment for Items Exposed to Combined Influence of Pressure, Force and Temperature 133
Project. Test Equipment for Items Exposed to Acoustic Pressure 134
Development of Cluster Equipment for Production of VLSI Chips 134
Project. Development of Cluster Equipment for Production of VLSI Chips 136
Project. Optoelectronic Measuring Modules in Technologic Complexes of "Cluster Equipment" or "Pilot Lines" Type for Checking Parameters of Semiconductor Structures 137
New Developments in Norm-Setting, Technologic Support of Electronics Industry 138
Project. Norm-Setting and Technical Support for Useful Life of Electronic Equipment Items (EEI) 143

Project. Certification of Production 144
Project. Karat-128 System for Parametric and Functional Checking of Microprocessor and Matrix LSI Chips 145
Project. International Standardization and Certification 145
Metrologic Support for Electronics Industry 146
Project. Standard Copies for Microelectronics 150
Project. Metrologic Support of Microelectronics Industry 151
Project. Outfit for Checking Static Parameters of Low- and Medium-Power Transistors 152
Project. Climatic Test Equipment 153
Project. Contact Devices for Test Equipment 153
Project. Optoelectronic Systems for Monitoring Parameters of Semiconductors in Microelectronics 154

Russian State Program for Development of Electronics Technology

957A0914A Moscow ELEKTRONNAYA PROMYSHLENNOST in Russian Jan 94 pp 1-180

[Collection of materials in special issue of journal, edited by A. S. Andreyev, 600 copies (signed to press 17 Nov 94)]

Resolution No 453 of the Government of the Russian Federation Dated 6 May 1994, Moscow

Russian State Program for the Development of Electronic Technology

[FBIS Translated Text] Assigning priority importance to the electronics industry, one of the basic economic branches the Government of the Russian Federation resolves.

1. To approve the draft of the Russian State Program for the Development of Electronics Technology (hereafter called the Program) submitted by the RF State Committee for the Defense Branches of Industry.

Designate the RF State Committee for the Defense Branches of Industry as the state client for Program implementation.

2. The RF Ministry of the Economy, the RF Ministry of Finances and the RF Ministry of Science and Technical Policy are to:

Examine funding of the Program in 1994 within the limits of the appropriations allocated to the RF State Committee for the Defense Branches of Industry;

During the period 1995-2000 provide for purposeful funding of the Program among the federal programs with annual refinement of the allocated appropriations.

3. The RF State Committee of the Defense Branches of Industry within a 3-month period will send to the Government of the Russian Federation under the established procedures proposals on:

— advantageous terms for loans and taxation of profits of associations, enterprises and organizations participating in Program implementation;

— organization of a federal fund for the development of electronics technology;

— protection of Russian producers of electronics equipment by means of state measures for exerting an influence in the customs, foreign trade and taxation policy fields.

V. Chernomyrdin, Chairman, Government of the Russian Federation

Russian State Program for Developing Electronic Equipment: Branch Strategy and Tactics

A. S. Andreyev, head, Main Administration of the Electronics Industry, State Committee for the Defense Industry

Progress in the scientific-technical and social sphere of life in modern society is determined to an enormous degree is determined by the development of electronic equipment items, the field of whose use is constantly expanding — from household radio and television equipment to controllable space vehicles.

Electronic equipment items (EEI) today and in the remote future are the principal component of macrosystems used for functioning of the final product. EEI ensure not only an all-inclusive conservation of physical resources and a reduction in the size of the final equipment, but also an increase in such important qualities as accuracy, universality and speed.

The principal goal in the development of and improvement in electronic equipment items is assurance of further economic and social progress. However, the process of developing EEI is rather broad in its structure and capital investment both in the scientific field and in the production sphere. With allowance for the special features of this process a state policy is being formulated in all the well-developed countries of the world, especially the United States, Japan, Germany, Great Britain, as well as the Korean Republic, Singapore, Taiwan, China and others which during recent years have made impressive advances in the development of their economy.

The program approved by the RF government provides that by the year 2000 Russian electronics will reach a level ensuring production of a final product on its basis corresponding to world standards and a competitiveness necessary for the preservation and development of the economic and defense potential of Russia and at the same time a fundamental structural change in existing exports.

This requires:

— development of new technologies for fabricating electron equipment items, determining the technical level of information and control systems, systems for communication, transportation, medicine, arms and military equipment, consumer goods, instruments and assemblies for the fuel and power industry, etc.;

— development of submicron technologies with a minimum topologic size 0.3-0.1 μm ensuring development of circuits with an integration level up to 10 billion elements per crystal (at the present time this level does not exceed 5 million elements per crystal);

— development of a new generation of microwave instruments operating in the millimeter and submillimeter ranges with an increased output power, plane screens for television screens and monitors, large-format high-resolution kinescopes and solid-state lasers with an increased efficiency;

— organization of modern production of electronic equipment items competitive on the world market;

— development of production facilities which by the year 2000 will ensure an increase in the volumes of production with allowance for their new technological variants;

integrated circuits by a factor of 5.7;

semiconductor instruments by a factor of 1.7;

resistors by a factor of 1.4;

capacitors by a factor of 2.5;

kinescopes by a factor of 2.1;

connectors by a factor of 4.4.

The program includes four interrelated subprograms defining its principal goals and the ways to solve them.

Subprogram 1. "Electronics Elemental Base" contains projects for development of the electronics equipment items needed for supplying systems for general industrial and military purposes.

Subprogram 2. "Basic and Practical Research" includes a list of research projects in priority fields of electronics equipment carried out by industrial institutes, the Academy of Sciences and institutions of higher education in the Russian Federation.

Subprogram 3. "Electronic Technologies" contains projects for developing technological processes necessary for the development and production of electronic components, solution of problems in ecology, standardization, reliability and quality.

Subprogram 4. "Resource Supply" deals with problems related to the development of industrial supply branches: materials science, electronic machine building, analytic and measuring equipment; individual sections are devoted to capital constriction, creation of clean production rooms and projects involving attraction of foreign investments.

This program, together with electronization of the economy, provides for solution of supply of weapon and military equipment systems with EEI, since in its content electronic technology is universal and is a dual-purpose technology.

However, such fields of electronic technology as microelectronics, instruments operating at superhigh frequencies, information display devices, quantum electronics and others used in modern systems as precise guidance, counteracting radar, radar and communication have their specifics and are being developed under multisided purposeful programs for creating military purpose systems.

In the microelectronics field there must be not only considerable development of the existing capacities, but also their significant renovation in accordance with modern technical, production and economic requirements, and carry out a great amount of basic and practical research.

The principal effort will be concentrated on the development and mastery of new technologies for creating functionally complex integrated circuits which to an ever-greater degree determine the appearance and technical level of modern electronic systems in the fields of communication, control, information science, etc. One of the principal goals is to saturate our own market to the maximum possible degree and enter the world market, winning our niche there.

Parallel with the development of microelectronics technology it is necessary to develop a branched network of collective centers for the designing of specialized and semispecialized integrated circuits on the basis of upper-level powerful computer systems and modern work stations for planners at the lower level of users.

The strategy for the development of technology is based on a qualitative changeover to the formation of structures with increasingly smaller sizes: from a technology of 2-1.5 μm to a technology of levels 1, 0.8, 0.5 and 0.3 μm. A decrease in the size of the structures requires a changeover to new technological procedures for their formation, rigorous control of the energy input, stabilization of technological temperature conditions to the level of several hundredths of a degree, control of concentrations to thousandths of a percent and introduction of complex monitoring of technologic parameters. A transition to the submicron region is accompanied not only by a decrease in the size of the elements, but also an increase in LSI chip integration, which makes it necessary to increase precision, improve reproducibility of technologic processing and reduce the level of the introduced defects. The creation of a technologic base at a new level is impossible without ensuring the development of superpure materials and in particular solution of the problem of production of silicon plates with a diameter 200-250 mm with the required level of perfection of the crystal structure.

The development of technology must proceed along the path of ever-greater integration of individual processes

into microcycles and automation of the production process on the basis of cluster specialized technological equipment. The goal of ensuring the formation of low-defect LSI chip structures will be solved by the introduction of ultrapure production, including in their infrastructure complexes of clean rooms, systems for the ultrafiltration of reagents and gases and ecologic monitoring systems.

There is to be a wide range of research work directed to the development of highly efficient technologic processes for the fabrication very large and very high-speed integrated chips (VLSI and VHSI), research on the development of new physical principles for the operation of instruments and creation of a fundamentally new generation of ultraminiaturized instruments in quantum nanoelectronics, including integrated in the effect of dimensional quantization, atomic memory devices, three-dimensional integrated circuits; search for ways to achieve technological embodiment of functional structures on new principles of action with functionally active layers having a thickness 4-2 nm (nanotechnology, atomic assembly).

The realization of these goals will ensure the reaching of the principal parameters of instruments at a qualitatively new level:

degree of integration of VLSI to 10^{9}-10^{10} elements per crystal;

high-speed signal processing in pico- and subpicosecond range;

size of elements 3-1 nm elements, memory capacity to hundreds of Gbit or more.

A changeover to a new generation of VLSI and VHSI will make it possible to create finished systems in a crystal, to broaden the functional capabilities of both the microcircuits themselves and equipment based on them.

In the field of microwave electronics it is necessary to retain a leading position in the world, meet defense needs for microwave instruments and broadly introduce them in the economy.

Basic and scientific research will be directed to a search for new technical solutions, including the technological and design principles for creating electrovacuum instruments (millimeter and submillimeter ranges) with an increased output power and wide-band characteristics, hybrid and hybrid-monolithic microwave instruments and devices, which will make it possible to ensure a substantial increase in the efficiency in operation of surface and space radars, long-range development of radio vision, all types of communication, fullness of analysis of electronic conditions, reduction in size and weight and broadening of the functional capabilities of equipment, creation on the basis of powerful microwave energetics of promising resource-conserving ecologically clean technologies for the lumbering, timber processing, food and tire industries, production of construction materials, agriculture and other economic branches.

Superconductor electronics will be developed in the direction of highly sensitive microwave detectors, highly sensitive microwave generators, powerful microwave electrovacuum instruments, instruments with ultrahigh sensitivity to magnetic fields with use of the high-temperature superconductivity effect and a fundamentally new elemental base on the basis of quantum coherent phenomena, which will make it possible to reach a qualitatively new level with respect to the principal parameters of the electronic instruments and microcircuits, including with respect to the speed of data processing in real time with an ultralow power consumption.

In the field of means for information display, due to the technical reoutfitting of existing enterprises, the mastery of modern technologies and the starting up of new facilities there will be assurance of the production of kinescopes meeting modern requirements and devices based on them.

The program includes development of a wide range of color television kinescopes of a flattened form with screen diagonals of 27, 32, 37, 42, 45, 51, 54 and 63 cm, large-format kinescopes with screen diagonals 72-86 cm with increased resolution (up to 1,300 lines), color display kinescopes with an increased resolution (up to 1,600 lines), ensuring reproduction of computer graphics and kinescopes for high-clarity television.

Plans call for leading-edge development of work on creating a number of color and monochromatic liquid-crystal matrix screens with a power consumption and weight and size characteristics 2-3 orders of magnitude less than kinescopes.

Plans call for the development of laser and cathode-luminescent cathode-ray projection tubes making possible assurance of production of collective-use data display units.

Theoretical and experimental research directed to development of new materials for flat screens, search for new technical solutions for the development of a new generation of special (including projection) and very bright cathode-ray instruments with increased resolution, operating with high illumination, will make it possible to develop a new generation of data imaging instruments (including small television sets, portable professional and personal computers), collective-use TV projection

systems with screens measuring up to 50 m^2 (including high-clarity TV).

In order to reduce the labor-intensiveness in manufacturing TV and display kinescopes it is necessary to carry out work related to the development of a complex for the production of glass covering and color-separation masks, as well as technological, assembly and control-measuring equipment. In the IR technology field it is necessary to create basic technologies for developing photodetection device (PDD) on the basis of CMT (cadmium-mercury-tellurium) materials, group A_3B_5 and others with a limiting threshold response up to 2 x 10^{-15} W/element, a spectral response region in the range 1.5-25.0 μ and a number of elements of matrix PDD up to 4 x 10^6, which makes possible a tenfold increase in the capability for the detection of objects against the background of radiation from the ground and cold sky, defects in heat- and gas-conducting networks.

In quantum electronics, by means of existing technical solutions, it is necessary to ensure attainment of parameters corresponding to world levels. The following will be developed:

integrated grids of powerful semiconductor lasers with phased radiation in continuous operating mode;

waveguide single-frequency CM lasers and pulsed TEA lasers with an increased power and radiation;

excimer lasers with a radiation power up to 6 J, including for photolithographic projection units employed in microelectron technologies.

It is necessary to develop research on new excitation and generation phenomena, search for new active media, development of fundamentally new technologies in the field of synthesis and processing if semiconductor structures and thin films. This will make it possible to develop a new generation of quantum electronics instruments, including solid-state lasers with an efficiency increased to 30-40 percent (instead of 2-8 percent at the present time), semiconductor lasers with a spectral range broadened to the visible region, superpowerful (10^{10}-10^{22} W/cm) radiation sources with ultrashort pulses in a range up to the X-ray range.

A changeover to a qualitatively new level of quantum electronics parameters will ensure an increase in density of the record and volumes of conveyed information in the field of information science, communication and telecommunications, development of new laser-stimulated technological processes and equipment for submicron and nanoelectronics.

In the piezoelectronics field provision is made for the development of an industrial technology for different classes of resonators and filters necessary for improving radio receivers and television, including satellite TV, radiotelephone communication systems, video technology, promising computers and other equipment.

With respect to technologies, it is necessary to carry out a number of studies for applying piezoelectric films for the manufacture of piezoceramic items with elements of submicron size.

In the field of passive electronic components (resistors, capacitors, switching devices, etc.) the goal is to meet fully the needs of the economy and defense, precluding the purchase of these items from abroad. The application of the latest advances in electronics technology will make it possible to improve reliability, weight and size characteristics, increase production in a modern design variant, including for surface mounting.

Simultaneously with meeting our own needs, the goal is recovery of lost markets abroad.

For this purpose it is necessary to carry out technological work ensuring broad introduction of direct mounting of electronic components on the surface of printing switching circuits.

In the field of power electronics plans call for the development and putting into production of items for currents of 2,500-3,000 A and voltages up to 5,500 V.

The implementation of the program for an electronic element base will accelerate modernization and renovation of machine building, transportation, metallurgy, electric power, instruments and equipment for agriculture, will make it possible to increase the reliability of this production by a factor of 5-10, a decrease in its weight and size by a factor of 2-5 and a decrease in the loss of electric power to the economy by 25-50 percent.

Supply of materials. A high percentage of the materials are supplied by industrial enterprises of the russian Federation, including the electronics industry. However, at the present time 275 materials are purchased abroad due the lack of their production or inadequate productivity of manufacturing plants.

Provision is made for carrying out a program of work directed to the generation of materials to replace imports (on the basis of Russian initial components) corresponding with respect to their technical level the level of materials produced by leading foreign companies and organization of their production, including in small-tonnage quantities.

The production of materials presently produced by the CIS countries, especially monocrystalline silicon, the principal material used in electronics, will be organized in Russia.

Implementation of the project will make it possible to supply the electronics industry with completely exceptionally pure materials, liquid and gaseous technologic media.

Measures for conducting their development, organization of production and constructing the necessary production facilities are coordinated with the branches producing or responsible for the production of materials and component parts.

Plans call for a great amount of basic and practical research directed primarily to providing solution of the problems involved in producing VLSI memory devices with a high degree of integration and belonging to the field of submicron technology, nanotechnology and precision studies of heterophase processes, surfaces, interfaces, structure and chemical state of materials. Provision is made for an increase in the quality of semiconductor materials, creation of silicon and gallium arsenide of large diameters with a density of dislocations less than 10 cm^{-2} and other semiconductor compounds with a low content of defects with an admixture composition regulable in the course of cultivation, creation and application of electronics of new classes of materials (superlattices, organic semiconductors, diamondlike materials, etc.), synthesis of organic materials for the creation of photo, X-ray and electron heterostructures and a technology for precision of chemical and ion etching of layers and mesastructures.

Provision is made for the development of special equipment for photolithography with the use of lasers with a radiation wavelength 200-190 nm and for practical implementation of the methods of electron-, ion- and X-ray lithography, nontraditional image-formation methods, creation of a new generation of equipment of the cluster type for processes of plasma etching, radiation-stimulated formation of functional layers, etc.

The new technical solutions require development work and the introduction of new technologies and delivery of materials.

Provision also is made for solving general technologic problems for all electronic technology fields:

— integration of technologic processes on the basis of multichamber systems (cluster equipment);

— automation of control and computerization of management of the technical production process;

— creation of a system of clean production rooms, including a supporting complex (filters, clothing, structures, materials, control of cleanness).

At the same time a major cycle of studies, associated with the urgent needs is planned in the ecology field. This involves predominantly the performance of work for increasing ecologic cleanness and safety of processes in electronics technology, which will make it possible:

— to increase the percentage of recycling of water in the production of electronics technology items up to 75-80 percent in the first stage of implementation of the Program (1993-1994), up to 80-85 percent in the second stage (1995-1997) and up to 85-90 percent by the year 2000;

— to increase the degree of recycling of exceptionally pure solvents up to 40 percent;

— to ensure in the technologic the trapping of harmful substances in different classes from 40 to 90 percent and completely preclude the dumping of contaminated sewage into open water bodies;

— to develop a technology and organize the reprocessing of the wastes of semiconductor production (degree of extraction in the form of elements and utilized compounds — not less than 95 percent).

In the field of capital construction plans call for the priority allocation of capital investments for the development of basic directions in the electronics industry, having a high scientific- technical potential. The subprogram includes work on completion of the earlier initiated construction of production facilities, including the 1-EG and 2-EG structures with ultraclean rooms of class 1-100 and projects for the construction of new production plants at a higher technologic level.

At the same time provision is made for technical reoutfitting and reconstruction of existing enterprises in the branch.

Plans call for capital investments in the necessary amounts for conversion programs for the respecialization, reconstruction, construction and technical reoutfitting of branch enterprises, as well as for creating facilities for the production of electronic equipment items, materials and equipment, deliveries of which from the CIS to Russia have been substantially reduced or have completely ceased.

It is necessary to revise the laboratory-experimental and technologic base of the branch, existing scientific research institutes and design bureaus for ensuring work in the fields of microelectronics, fiber optics and laser technology, special technologic equipment and materials, as well as for carrying out defense programs.

Clean production rooms (CPR) are a complex engineering complex whose development and production

must be accomplished by a specially established industry dealing with the problems involved in planning and construction.

Participating in the implementation of this subprogram are enterprises of the RF Ministry of Atomic Energy, having considerable scientific and production for creating clean production rooms and systems for preparing and transporting technologic media.

Program implementation will require investments during the period 1994-2000 in an amount of about 15,000 billion rubles in the prices of the first quarter of 1994, including 73,000 [as printed] billion rubles for scientific research and design work.

The large-scale implementation of projects of the Russian State Program for Development of Electronic technology under the new economic conditions also requires new approaches with respect to the funding of the adopted decisions on management of implementation of the Program and state measures in the field of tax, customs and foreign trade policy.

The funding of the scientific research and design work will be ensured by:

— sums for contractual work for orders of enterprises and organizations or related industrial branches, constituting 16 percent of the total volume of work;

— their own funds from the profit remaining at the disposition of enterprises with allowance for additional advantages (30.5 percent);

— sums from deductions into the unbudgeted fund for scientific research and design work (1.5 percent);

— allocations from the state budget for conducting basic and practical scientific research work (47 percent);

— attraction of private capital and foreign investments (5 percent).

The funding of the amounts for capital investments will be ensured by:

— their own from the profit remaining at the disposition of the enterprises with allowance for additional tax advantages (50.6 percent);

— state appropriations (44.4 percent);

— attraction of private capital and foreign investments (5 percent).

When making purchases of special materials abroad which are nor produced by Russian industry in inadequate quantity it is necessary that the state allocate foreign exchange sums for the period up to the year 2000.

One of the important elements of the Program is funding by foreign investments.

It is necessary to use foreign loans for the purchase of licenses for the production of modern electronic technology items, individual types of special technologic and control-analysis equipment, setting up enterprises with fractional participation of foreign corporate bodies and citizens, as well as enterprises or their branches belonging completely to foreign investors.

Preliminary negotiations carried out with American, Japanese, German, French, Italian and other countries show the readiness of a large number of companies to develop cooperation and make investments in the Russian electronics industry, especially in the following fields:

— microelectronics items, including specialized integrated circuits with a technologic level 0.8-1.0 μ in 1994 and 0.3-0.7 μ in the stage 1995-1997;

— information display instruments, including color TV and display kinescopes, color and monochromatic liquid-crystal matrix screens, laser projection cathode-ray tubes for collective-use information display instruments;

— quantum electronics instruments for establishing modern communication systems, local computer networks and space communication;

— electronics goods for the general public (VCRs, microwave ovens, video cameras, household computers).

The choice of projects will be made on a competitive basis and the principal efficiency tests should be:

— times for implementation and technical level of projects, making it possible to organize the standard production of items corresponding to world standards;

— repayment of the loans advanced by foreign exchange sums at the disposal of the newly established or modernized enterprise.

The principles for implementation of the Program set forth above will ensure a high efficiency of the directed investments and at the same time will have a considerable social effect. The net reduced income with these factors taken into account will be 87.7 billion rubles during the report period.

The profitability of the capital investments in the Program will thus be 204 percent, that is, the "net income" (total income, minus all the payments associated with obtaining it) will be double the capital investments. For all practical purposes this indicates that after completion of the performed work the enterprise will recover all the expenditures over the course of less than a year.

The social advantage of Program implementation will include:

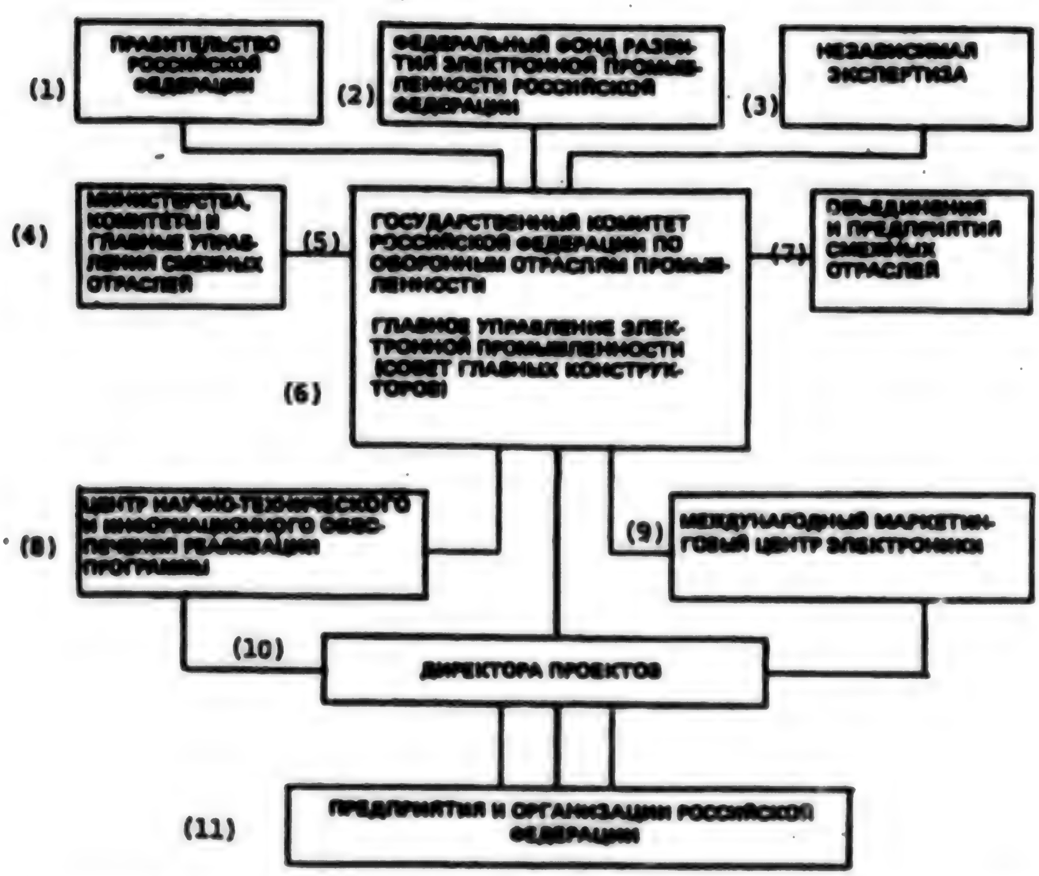
— increase in the number of jobs both in the electronics industry and in other economic branches and fields;

— increase in the standard of living of the entire population of Russia, especially those in the electronics and related branches;

— practical structural reorganization of internal and external budget receipts from raw material natural resources (for the most part unexploited) to high-technology finished production.

Structure of Administration for Implementing Russian State Program for Development of Electronic Technology

СТРУКТУРА УПРАВЛЕНИЯ РЕАЛИЗАЦИЕЙ РОССИЙСКОЙ ГОСУДАРСТВЕННОЙ ПРОГРАММЫ РАЗВИТИЯ ЭЛЕКТРОННОЙ ТЕХНИКИ



Key: 1. Government of Russian Federation 2. Federal Fund for Development of Electronics Industry of Russian Federation 3. Independent expert evaluation 4. Ministries, committees and main administrations of related branches 5. RF State Committee for Defense Branches of Industry 6. Main Administration of Electronics Industry (Council of Chief Designers) 7. Associations and enterprises of related branches 8. Center for Scientific-Technical and Information Support for Implementation of program 9. Electronics International marketing Center 10. Director of projects 11. Russian Federation enterprises and organizations

Implementation of the Program provides for the following organization of its control and monitoring.

The Main Administration of the Electronics Industry of the RF State Committee for the Defense Branches of Industry:

— coordinates implementation of the Program and carries out ongoing oversight of the course of its implementation;

— organizes competitions for the right of participation of enterprises and organizations in implementing the Program;

— ensures funding of projects winning in the competition;

— prepares tasks for delivery for state needs of technical and industrial production and also tasks for the construction and reconstruction of enterprises and monitors their implementation;

— ensures implementation of the work provided for by the Program by enterprises and organizations;

— organizes the implementation of independent expert evaluation of the presented projects.

The independent expert evaluation results in an analysis and choice, on a competitive basis, of projects directed to implementation of the Program. The projects can be supplemented and changed on the basis of the results of the expert evaluation. The Independent Expert Commission is made up of authoritative representatives of science and industry of different economic branches.

The directors of the projects — the leaders of the work conducted under the Program by competition — are responsible for implementation of the project and are given the appropriate administrative and management powers with respect to the organization and coordination of work, obtaining and using the required financial and material resources.

The directors of the projects are designated by the Main Administration of the Electronics Industry on a contractual basis.

The Federal Fund for the Development of the Electronics Industry accumulates the financial resources directed by the state for the development of the electronics industry, sums from the privatization of enterprises, sums from private individuals and foreign investors, as well as centralized sums forming due to deductions from the price of the realized production for conducting the conversion of the military production of enterprises participating in implementation of the Program.

Sums from the Federal Fund are distributed on a competitive basis under the condition of accountability for their use and their returnability.

The Center for Scientific-Technical and Information Support for Implementation of the Program is being developed on the basis of the Elektronika Central Scientific Research Institute, Tsiklon State Central Scientific Research Institute, State Fuels Scientific Research Institute, Elektronstandart Regional Scientific Research Institute and PKO Soyuzelektronproyekt in accordance with the fields assigned to them and performs:

— many-sided evaluation of the development of the scientific-technical and production base of the electronics industry, proceeding on the basis of the goals and tasks of the Program and the course of its implementation;

— supplying information to interested enterprises and organizations on the scientific, technical and production activity in the branch and course of implementation of economic reform.

The Electronics International Marketing Center is being established and will carry out its activity under fully self-sustaining conditions.

The Marketing Center ensures favorable conditions for broadening the production of high-technology products on the basis of international economic, industrial and scientific-technical cooperation with the attraction of foreign capital and also an increase in the export potential of enterprises in the electronics industry of the Russian Federation.

A decree of the President of the Russian Federation has now been prepared on advantages with respect to loans and taxation of associations, enterprises and organizations participating in implementation of the Program, as well as resolutions of the RF Government on the Federal Fund for the Development of Electronics Technology and on protection of Russian producers of electronic equipment.

The content of these legislative documents in general reflects both the guaranteed participation of the state in the development of Russian electronics and stimulates the attraction and involvement of Russian and foreign enterprises and organizations.

The Main Administration of the Electronics Industry of the RF State Committee for the Defense Industry during recent years has carried out selective innovation and investment support within the limits of the allocated budgeted sums and loans of enterprises and organizations with the goals and tasks of the Program taken into account.

Also planned is much purposeful work on the international testing and certification of electronic equipment items and production on this basis, analysis of economic and scientific-technical work in implementing the Program, its funding and the effectiveness of innovation and investment projects.

Electronics Branch and Russian Military Doctrine

A. S. Andreyev, full member, RF Academy of Technologic Sciences

The existing armament for supply of the Russian Army and Navy has been produced using Russian electronics, corresponding to the most rigorous requirements with respect to a set of parameters, including with respect to resistance to exposure to ionizing radiations and cosmic factors.

Russian industry occupies one of the leading positions in the world with respect to military microwave technology, quantum electronics, microphotoelectronics, information display devices and semiconductor instruments. A lag in microelectronics has been noted during recent years. This is attributable primarily to the absence of plants with superclean production conditions.

Proposals to purchase the elemental base abroad for the outfitting of weapons systems can inflict irreparable losses.

First of all, foreign companies sell an elemental base for civilian purposes not corresponding to the requirements dictated by exposure to special factors, severe mechanical and climatic impacts. There is not a single country which sells electronic items for military purposes, much less specialized integrated circuits with special software.

Second, the reliability of the purchased elemental base for civilian purposes does not meet military technology requirements; it does not pass special stiff rejection tests. Among the computers purchased in the United States and other countries during the last five years for 18 billion dollars 40 percent have already broken down.

Third, with the imported elemental base of different countries with different programming there is an inevitable blind alley in the organization of repairs and the operation of armaments.

The principal goal in military-technical assurance of national safety, defined in the "Fundamental Points in Russian Federation Military Doctrine," adopted by presidential Decree No 1833, dated 2 November 1993, is timely outfitting and material support of the Armed Forces with effective weapons systems, military and special equipment and property in the quantities necessary and adequate for guaranteed protection and vitally important interests of society and the state.

The following can be defined among the principal ways to attain this goal:

— creation of systems of arms, military, specialized equipment and property ensuring combat effectiveness by means of every possible increase in the quality indices of arms;

— supplying the Armed Forces with effective copies of arms and military equipment, assurance of their everyday operation;

— application of the latest scientific-technical advances, leading technologies and progressive materials when carrying out scientific research and experimental design work for the advanced development of new arms and maximum use of mathematical simulation for evaluation of their combat effectiveness;

— ensuring the necessary production and mobilization capabilities of industry for the production of arms.

Radar equipment for military purposes is the principal component part of modern weapons system and military equipment. Its percentage is approximately half the cost of military equipment and will be increased further in conformity to the increasing demands on the upgrading of combat efficiency and viability of military equipment under different application conditions. This is confirmed by data from the US Department of Defense in 74 percent of the total purchases of arms for the eight most important defense branches electronic equipment accounts for 27 percent, which with allowance for the 85 percent of military purchases of computers amounts to virtually half of all purchases of the Department of Defense in the defense branches of industry.

There is an increasing role, in particular, in developing highly efficient systems for control of the armed forces and strategic warning of missile attacks, the importance of which in modern armaments requires no detailed explanations. The recent major military conflict in Iraq demonstrated that highly precise weapon and electronic warfare systems are of equally great importance in military operations. For example, the use of 1 percent highly precise weaponry by the United States and its allies among all the other systems employed, highly precise weaponry accounted for about 50 percent target damage.

A characteristic example of weapons control problems solved by electronics is the operation of the scanning-targeting system of a future interceptor aircraft whose principal functions involve a need for simultaneous detection, tracking and weapon guidance to a stipulated number of targets (10-20) with an accuracy in determining coordinates ± 0.2-0.5°.

The time for processing of each target is not more than 0.5 s.

Calculations show that for data processing in the stage of tracking and identification the capability of the computer for the scanning-targeting system is 10^{8-9} operations per second.

That is, for solution of this problem in real time it is necessary to use fundamentally new algorithmic architectures and physical principles for building computers. However, even in the case of creating parallel computers developed on the basis of RISK processors, the capability of the latter must not be less than 10^{9}-10^{10} operations per second.

The requirements on production levels for different weapons control systems are given in the table.

As indicated by an analysis, a substantial increase in the efficiency of electronic weapons systems cannot be achieved without using in them the latest electronic devices based on the latest technologies and materials.

Systems	Computation rate, millions of operations/s	
	1995	2000
Electronic counteraction systems	25-100	1,000-10,000
Communication systems	10-30	500-2,000
Radar>	1-10	100-500
Sight reconnaissance systems	10-20	200-1,000

On the basis of the cited data and the fundamental principles for supplying the Armed Forces with weapons and military equipment we will examine the priority directions in the electronics branch of industry, which on the basis of basic and practical research is directed to the attainment of outstanding results in the fields of electronic technology fundamental for producing arms; microelectronics, microwave electronics (including high intensities), discrete functional devices for the ultrafast processing of great masses of data, optoelectronics, quantum electronics and information display systems, which will make it possible, in particular, to automate both individual operations and also full conversion of weapons to automated control (for example, robots for tanks, artillery, aircraft, helicopters, etc.).

The basis for development of a future elemental base of new generations is the priority development of high and ultrahigh technologies in microelectronics, nanoelectronics, molecular-beam epitaxy, as well as the development of ultraprecise analytic control methods. In support of this work it is necessary to improve materials for silicon technologies and technologies based on A_3B_5 and polymer materials.

The key point in implementing the programs for developing military equipment is the reliability of operation of electronic instruments ensuring reliability of processed signals and attainment of stipulated weapon accuracy.

The prospects for the development of Russian electronics will make it possible to create the necessary elemental base for a new generation of military technology.

In the microelectronics field:

— development work is being carried out on the technology of a wide variety of LSI chip memory devices with an information capacity for a dynamic memory of 256 Mbit-1 Gbit; for a static memory — 16-64 Mbit. For computers used in military satellite systems — development of a gallium arsenide memory and SOS/SOI with a capacity up to 256 Kbit with a speed 2-5 ns and increased resistance to radiation;

— reliable computers are being designed on the basis of basic matrix crystals of a high reliability, with low cost indices, with a number of gates per crystal 10^6 and a lag time 0.2-0.3 ns;

— development of a broad range of highly productive microprocessor silicon-based LSI chips with an increased functional complexity with a capability up to 64-128 bit and a performance up to 10^8-10^9 operations per second and microprocessor gallium arsenide LSI with a capability up to 32-64 bit and a performance up to 2 x 10^9-10^{10} operations per second, which are characterized by resistance to ionizing radiation and retain a functional capability in a wide temperature range;

— new single-crystal computer systems with a density of 10^7-10^8 equivalent logic elements will increase the capability of computers developed on their basis to 10^9

operations per second and a useful life on spacecraft up to 25 years;

— for coupling devices in computers and TV systems, especially for solving problems in radar, television, precision measurements and automated control systems, work is being developed on data conversion devices (digital-to-analog and analog-to-digital converters), including: precision, with 16-20 binary digits, high- and ultrahigh-speed with 6-12 binary digits, including with self-correction of systematic errors and self-diagnosis;

— development of the scientific principles of nanotechnology for the purpose of studying the possibility of creating ultraminiaturized supercomputers with a capability up to 10^{12} operations per second, analog devices for microwave equipment for electronic counteraction systems operating in the frequency range up to 10 GHz, systems for detection of targets with a minimum reflecting surface having a high degree of noise immunity due to the use of phase processing of wide-band signals.

In the microwave electronics field:

Creation on the basis of fundamentally new technologies and materials:

a new class of wide-band highly reliable multimode electrovacuum instruments with an increased (by an order of magnitude) output power for multifunctional electronic weapon systems;

a new class of solid-state modules for active phased antenna arrays and frequency synthesizers based on monolithic microwave microcircuits, including for bistatic radar;

active microwave elements based on transistorized HEMT structures with cutoff frequencies greater than 500 GHz. Functional monolithic circuits with working frequencies up to 200-300 GHz are being developed on the basis of a technology with a minimum size 0.05-0.1 μ.

For exploiting the frequency range above 10^{12} Hz development work is being done on the scientific principles of vacuum microwave microelectronics and relativistic electronics.

In the optoelectronics field:

A special place in creating military equipment is occupied by optoelectronics due to the exceptional functional breadth of the problems to be solved: assurance of noise-immune transmission, reception and processing of information; galvanic uncoupling of assemblies and units of electronic equipment of information systems and computer complexes from internal and external electromagnetic interference from large power plants, nuclear explosions, space, etc. A typical example of the elemental base of optoelectronics widely used in military equipment is optopars and optoelectronic systems based on them, semiconductor light-emitting diodes, symbol-sy thesizing indicators for information display on control panels in both surface and air and spaceborne equipment.

It is possible to formulate the following promising requirements for optoelectronic devices:

— spectral range of IR emitters 0.85-1.55 μ with speed 15-10 ns;

— speed of optopairs 10-20 ns, and optoelectronic matrix commutators to 1-2 ns;

— specific light force of superconductor digital and matrix symbol-synthesizing indicators and modules of semiconductor screens 100-150 μKd/mA;

— multiple channels (8-10 channels) of optoelectronic instruments;

— creation of optoelectronic receiving-transmitting modules for transmission of optical information signals through fiber and open optical communication channels at a rate 300-500 Mbit/s;

— development of matrix IR emitters for open optical communication channels with a power 3-5 W and an information transition range 3-5 km, which will make it possible to create operational noise-immune telephonic communication under field conditions and also communication for remote control of aircraft and missiles.

In the quantum electronics field:

The following are being developed:

— new generation of semiconductor lasers emitting in the IR, visible and UV spectral ranges with output power densities up to 100 W/cm^{2}at the resonator limit with a useful life up to 10^5 hours;

— matrices andlines of semiconductor lasers with surface radiation for pumping high-energy and efficient solid-state and fiber lasers with a pulse power up to 10 J and with a power of continuous radiation up to 200 W;

— a series of high-resistance (up to 10 W in a continuous mode) semiconductor lasers on an "amplifier-oscillator" basis, integrated in a single active element for fiber optic and space communication, optical memory devices with a registry density up to 10^8 elements/cm^2 for superhigh-speed transmission and processing of information.

In the information display systems field:

— creation of matrix, including large-format liquid-crystal screens of a new generation conveying a large amount of information for the display of operational information, flat screens with a diagonal of 25 cm, a reaction time not greater than 60 μs and a contrast not less than 5:1 for reproduction of a high-resolution color image (1,024 x 1,024 elements);

— development of new cathode luminophors, color kinescopes, cathode-ray converters based on new principles, including projection principoles, with low-voltage excitation and with the possibility of observation under high illumination conditions;

— creation of color gas-indicator converters in the form of full-format TV screens corresponding to the first and second TV standards intended for manufacturing receiving and videocontrol devices for individual and collective use.

In the passive and functional radio components field:

— creation of new piezotechnology devices, acousto-electronic devices with a piezoactivity greater than 0.53, thermostability better than 0.3 percent, quality greater than 750 for the realization of miniaturized piezoresonators in the microwave range for a new generation of transducers and navigation systems; — creation of metallic film and microcomposition precision resistors and functional devices based on them with a minimum TCS up to 10^{-6} K^{-1}, time stability not worse than 0.01-0.001 percent, which will make it possible to ensure a broad range of development work on military-purpose equipment;

— miniaturization increase in specific characteristics to 0.5 F/dm^2, 130 $\mu C/cm^3$ with a decrease in the cost of ceramic and film capacitors, including oxide-semiconductor capacitors, by a factor of 100;

— development of special transducers for robotized military equipment.

For the successful implementation of such a large-scale program, especially under conditions of the political-economic situation now prevailing in Russia it is unusually important to take into account the principal points in the concept of the State Program for the Development of Electronics Technology and effectively use the created defense-industrial potential of the Russian Federation.

Implementation of the tasks requires not only solution of scientific-technical problems, but also important organizational measures, including:

— completion of restructuring of industry, ensuring military-technical and economic independence of states under conditions of transition to a market economy;

— improvement of systems for state control of development work and production of military technology under conditions of a change in the forms of ownership;

— introduction of systems for financial-economic regulators and mechanisms directed to supplying of defense orders for all types of resources, and also for creating economic interest of enterprises of different forms of ownership for creating and producing military equipment;

— offsetting possible negative consequences of decrease in the volumes of military development work and production;

— guaranteed provision of financial and material-technical work resources for production of armaments;

— introduction of a contractual and competitive basis in the system of orders, development work and production of military and military-oriented products;

— organization of research and development work on promising technologies, competitive with and replacing imports, including dual-purpose technologies;

— constant exchange of dual-purpose technologies and their use with allowance for the interests of the state and producers;

— implementation of a loan-funding policy ensuring the filling of defense orders;

— support of the rates of rearmament of the armed forces corresponding to the needs of reliable assurance of military security.

It is particularly important to note and emphasize the possibility and desirability of military-technical cooperation between the state and foreign countries, in particular, for the development of the scientific-technical and experimental base of the defense branches, including the electronics industry. Such cooperation, other than yielding foreign exchange for state needs due to deliveries of armaments and military equipment, as well as conducting joint or special-order work for creating new models of armaments, will ensure strengthening of the military-political position of the state in different regions of the world and will make it possible to support the export potential of the country in the armaments field at the necessary level.

The Russian Federation is giving priority importance to establishing under mutually advantageous conditions of the cooperative relations of the enterprises forming

the defense-industrial potential and the branch scientific research institutions of the states which are CIS members. To a high degree this also applies to the electronics branch of industry because after the breakup of the USSR a considerable percentage of the extremely important enterprises of this branch were outside the borders of Russia.

Basic Submicron Technologies — Present and Future of Microelectronics

V. I. Zhiltsov, doctor of economic sciences, corresponding member RE Academy of Technical Sciences, and V. V. Martynov, doctor of technical sciences, professor

Microelectronics is creating the elemental base for all modern systems for the reception, processing and transmission of information, telecommunication and communication systems, systems for the automatic control of production, individual and specialized computers.

Microelectronics for all practical purposes is the technologic leader of modern times because it is further developing and producing the most complex, perfect and large-series production, having a high efficiency in their use. Microelectronics not only determines the leading edge of scientific-technical progress and the level of the defense potential of the country, but also is providing the premises for developing a unified basis for high technologies.

The foundation of this basis is a series of microelectronic basic technologies, the degree of whose perfection determines the possibilities for creating new classes of VLSI chips, an increase in the quality level and technical specifications, improvement in the technical-economic indices of standard production and an increase in the competitiveness of items.

Within the scope of the State Program for the Development of Russian Electronics provision is made for the development of a series of submicron basic technologies. Multisided programs for submicron technologies have been developed for solving this problem, highly important for the development of microelectronics, and are being implemented.

The programs are integrating the development of new technologic processes, special technologic equipment, materials, systems for ensuring ultraclean production facilities, CADS, modeling and fundamental research on submicron structures. Taking into account the need for the speediest possible implementation of the practical results of the development of submicron technologies, the overall problem is divided into stages.

First stage 1993-1994 — development of the basic microelectronic technology for VLSI chips with minimum sizes of elements up to 1.25-0.8 μ, degree of integration up to 5 million elements per crystal. For practical purposes the implementation of this task is being carried out within the scope of the Program for Setting Up Pilot Lines for Submicron Technology at the Mikron, Angstrem and Elektronika Joint-Stock Companies and provides for the development of a new-level technology and the entire supporting technologic complex. Upon completion of this stage experimental production of VLSI chips with submicron sizes will be organized for meeting the tasks of design of a new generation of special- and general-use electronic radio equipment.

Second stage 1995-1997 — development of basic submicron technologies for VLSI chips with sizes of elements 0.8-0.5 μ, degree of integration up to 100 million elements per crystal.

This task is being implemented within the scope of the Many-Aspect Submikron Program, which for all practical purposes is the technologic section of the Research, Development, Testing and Engineering Plan of the branch in the microelectronics field.

The program as its final goal provides for:

— formulation of the scientific principles and creation of a silicon technology for VLSI chips with topologic elements measuring 0.3-0.8 μ ensuring development of VLSI chips at the long-term memory 64 Mbit complexity level;

— formulation of a group of supporting technologies and measures, including the creation of experimental production and checking of the basic technology developed in it in the example of production of a number of VLSI chips;

— development of technical production projects, including means for support and control of construction, ecologic projects, a complex of special technologic equipment and materials, analytic and control equipment for the organization at newly established specialized enterprises of the electronics industry of the production of items at the level of complexity 64 Mbit long-term memory and basic matrix crystals with a logic complexity 1 million logic gates.

With respect to its structure, basic principles of implementation and tasks the Program has continuity relative to the Purposeful Many-Sided Program for the Development of Basic Technologies for Pilot Lines 1.25-08μ and ensures their further development into the submicron region and is consistent with the programs for the development of cluster equipment and exceptionally pure materials for electronic technology.

The third stage 1998-2000 represents a changeover to basic microelectronic technologies with the maximum attainable levels of parameters (minimum size of elements 0.3-0.1 μ, degree of integration of ultra VLSI chips up to 10 billion elements per crystal). The basis for the technology will be stimulated processes of formation and modification of ultrathin structural layers to 5-10 nm with the attainment of the required precision level (+/-0.3 μ for the size of elements, +/-0.5 percent for the principal parameters of the structural layers) and defects (not more than 0.01-0.05 defects/cm^2 for the control of defects greater than 0.05 μ).

The development of basic submicron technologies and their implementation in experimental production on a new supporting base for special technologic equipment, ultrapure materials and clean production rooms already in the immediate future will make it possible to proceed already in the immediate future to proceed to the creation and production of a new class of microelectronics items.

In accordance with the Program for the Development of Electronics Equipment items plans call for the following levels of development of VLSI chips.

Microprocessor VLSI Chips

The development of submicron technology for CMOS, bipolar CMOS and SOS (silicon on sapphire) structures will make it possible to create a variety of microprocessor VLSI chips with a precision 16-64 bit and a speed from 1 million operations per second to 50 million operations per second. Provision is made for the development of VLSI chips with the digital processing of signals, creation on their basis of a single-crystal processor for microprocessors with a precision 16-32 bit and a speed 5-12 million operations per second, as well as specialized processes for performing spectral analysis (speed 100-20 million operations per second), which will substantially increase the reliability of processing of information, increase the capacity of computer systems and handling capacity of information networks. The use of a technology based on complex semiconductor compounds (GaAs) will broaden the possibility for increasing the speed to 200-500 million operations per second.

The development and organization of the production of super VLSI of the class cited above will for all practical purposes solve the problem of creating a Russian basis for electronic components for highly productive computer systems, systems for the processing and transmission of images, telecommunications and communication and special and household systems of electronic radio equipment and will reduce expenditures on the creation and production of electronic radio equipment by a factor of 3-4.

Integrated Memory Circuits

On the basis of CMOS and bipolar CMOS structures and the developed submicron technologies provision is made for the development of VLSI chip long-term memories with a capacity up to 4 Mbit in the first stages and up to 64 Mbit in subsequent stages with assurance of a time of selecting the address up to 35-50 s. The bipolar MCOS technology will make it possible to create a memory and energy nondependent ROM with a capacity 1-6 Mbit, selection times up to 20 and 100 ns respectively and an information storage time up to 10 years.

The development of a new class of VLSI memory chips, which are the largest-scale product in electronics, will ensure the loading of the production facilities of the Russian microelectronics industry and will increase the exportation of integrated circuits and will provide developers of electronic radio equipment broadened possibilities for the designing of new types of equipment, reduce expenditures on the creation and improve the indices of electronic radio equipment by a factor of 5-6.

Basic Matrix Crystals (BMC)

The development of a variety of BMC on the basis of submicron technologies of CMOS and bipolar CMOS structures will make it possible to create an instrument base for the fabrication of micropower semi- special-order VLSI chips, which will sharply reduce the development work period (up to 3-4 weeks instead of one year), will increase the efficiency in designing VLSI chips and electronic radio equipment, will intensify the dynamics of creation of new types of equipment of the broadest range.

Plans call for creating BMC with a number of logic gates from 30,000 each to 200,000-500,000 each per crystal and a delay time per gate up to 0.2-0.5 ns. Variants of technology based on complex semiconductors will make it possible to reduce the delay time to 0.05-0.1 ns per gate, which is evidence of the possibility of using BMC of such a class for creating supercomputers.

Digital-to-Analog and Analog-to-Digital Converters, Operational Amplifiers, Linear Circuits

The specifics of development of this type of IC is governed, in particular, by the fact that due to the breakdown of the USSR the principal developers and manufacturers wound up outside Russia. Specifically digital-to-analog and analog-to-digital converters and operational amplifiers are the basic component base for creating checking and automatic control systems and information-measuring systems for special and general purposes. Despite the fact that at the present time there is a pressing need for recreation of a base for the production of digital-to-analog and analog-to-digital converters in Russian microelectronics on the basis of existing technologies (the work is being done under the Converter Program), the use of submicron basic technologies is ensuring a substantial increase in

the quality of new IC. The program provides for the development of functionally complete sets of precision digital-to-analog and analog-to-digital converters with a precision 12-20 bit and a stabilization/conversion time 5-20 μs, speedy converters with a precision 6-12 bit with conversion frequencies 50-200 MHz and frequencies up to 0.5-1 GHz for converters with use of a technology with complex semiconductors.

Integrated Circuits for Radio, Video and TV Equipment

The principal objective is the development and organization of the production of sets of IC for fifth-generation TV receivers, assurance of development of space communication systems and development of a modern elemental base for radio and video equipment. Development work is already being done on an LSI chip for the receiver and transmitter of the control channel, radio channel demodulator, frame scanner of a teletext decoder, high-voltage video amplifier and other basic units of a modern TV. A changeover to submicron technology will really make it possible to proceed to the development of an elemental base for high-clarity TV, digital reception and processing of an image, single-crystal variants of radio and TV receivers with liquid-crystal screens and substantially improve the technical and economic indices of the developed electronic radio equipment.

Many-Sided Development Work on Basic Submicron Technologies

The changeover to submicron technologies is a complex task which affects virtually all supporting systems (equipment, materials, clean production rooms, ecologic support, etc.); it requires the creation of a new class of CADS, implementation of a work program for modeling of technologic and electrophysical processes using two- and three-dimensional models. As a solution for these problems plans call for the creation of combined and local networks of automated work stations (AWS) for the technologist and developer and a CADS for the through designing of submicron VLSI chips.

The development of the new elemental base of VLSI chips and submicron technology must be based on deep basic research, especially in the field of:

— surface of superconducting materials and interfaces of functional layers — crystallographic studies of silicon and clarification of reasons for the appearance of local defects of dislocations and working out of principles of control and checking of the level of defects;

— heterophase reactions on the surface of a solid body in the cleaning and formation of functional layers;

— principles for self-formation of structures;

— self-diagnosis systems and principles for the functioning of supersystems.

An increase in the pinpointing of study of formed semiconducting structures is acquiring special importance.

An analysis of submicron structures and methods for their realization shows that radiation-stimulated processes must become the basis for submicron technology. The technologic process must be continuous, based on the maximum possible number of operations, uniform in their physicochemical mechanism, ensuring a controllable energy influence on the formed structures, minimum contamination and defect formation.

Special technologic equipment must ensure the reliable protection of the plates against external condition conditions and work on the principle of "determined processings," which provides for the need for aggregation and automation on the basis of many-sided operational control and mathematical simulation of processes.

The following fundamental principles lie at the basis of development of basic submicron technology:

— assurance of a high degree of pinpointing and selectivity of the processing of structures due to the introduction of stimulated processes with a rigorously controllable energetics of the active particles and composition of the technologic medium;

— individual sequential processing of plates in automated equipment systems (of the cluster type) with built-in operational technologic control;

— exclusion of the subjective factor of the operator due to a high degree of automation and processing in continuous cycles (microcycles).

The greatest selectivity and pinpointing of the effect can be achieved when using fluxes of particles with controllable energetics, as well as with control of the temperature of the processed plate (cryogenic processings), which will make it possible to avoid an undesirable thermal redistribution of the concentration in the formed regions and a substantial increase in the selectivity of the etching.

Radiation-stimulated processes in full measure meet the requirements of low-temperature, highly selective and highly anisotropic technology. These include processes in which the technologic agent used is a flux of particles (electrons, ions, radicals) or quanta (visible, UV, X-radiation). The following are used in submicron technology: plasma processes, stimulated by ions and radicals (precipitation, etching); electron processes (electronolithography); ion processes (ion implantation, lithography, implantography, etching, surface modification); processes stimulated by electromagnetic radiation in the visible, UV and X-radiation spectral ranges (lithography, formation of functional layers).

The most promising are photostimulated processes ensuring the absence of radiation damage, high selectivity of processing and relative simplicity of implementation. There is great scientific and practical interest in a complex of work on developing a gas-phase technology for the cleaning of plates, where use also is made of radiation-stimulated processes. Precisely for this reason submicron technology must be based on low-temperature selective processes employing photon, electron and ion beams and fluxes of free atoms and radicals.

The changeover to submicron structures is accompanied by a sharp increase in sensitivity to external conditions and the degree of contamination, which dictates a need for rigorous use of processing in microcycles with use of cluster equipment, provisions for transport and storage of plates in closed (sealed) systems.

Even such a schematic and concise examination of the specifics of creation of basic submicron technologies indicates an organic relationship of the programs for their development and programs for special technologic equipment (Klaster [Cluster] Program), ultrapure materials, analytic equipment, supporting complex, basic and practical research.

An important task in the changeover to the programmed principle for the development of microelectronics is a solution of the problem of the priority of the programs, their interlinking with respect to the performance of reciprocally supporting and mutually supplementing work, flexible planning and continuous monitoring for the purpose of effective application of the intermediate results obtained.

In proceeding to the practical implementation of submicron technologies, it must first of all be taken into account that the technologies must be developed on systemic principles.

Systems technology constitutes a series of technologic operations for the fabrication of an item and support systems at all production levels, rigorously reduced to algorithmic form.

The duration of the technologic cycle and the attained percentage of yield of suitable products must be included among the principal characteristics of systems technology. The dynamics of variation of these parameters with time determines the degree of perfection of the organizational-technical part of systems technology. The production cycle, determined by the reliability and organizational characteristics of production, for "normal" production is 2.5-3.5 of the duration of a "pure" technologic cycle. The better Japanese microelectronics companies attain indices 1.5-1.8, which is evidence of the highest degree of organization of production.

The percentage of yield of acceptable items characterizes the degree of perfection in the design of VLSI chips, the degree of resistance of the technology to external disturbing factor, perfection in implementation and support o the technologic process, stability of characteristics of the used materials, level of skills of production personnel and perfection of the control system.

The anticipated progressive changes in the technology for the production of new generations of electronic equipment items are related primarily to an increase in the degree of cleanness of production facilities. Experience shows that the profitable production of VLSI chips is possible only if the size of the contaminating particles does not exceed the level 0.2-0.1 of a minimum topologic element and the density of defects on the processed plate is less than $0.01/cm^2$.

An important factor in ensuring stable and efficient production of VLSI chips is the meeting of the full range of purity requirements and retention of the stability of INDO parameters with time. The modern production of VLSI chips, together with limiting requirements on the cleanness of the laminar flow of dust-free air (class 1 and 10, with a particle size 0.1 μ) advances requirements on thermostabilization of the air medium no poorer than +/-0.2 K, maintenance of relative humidity no poorer than 3-5 percent, ultrafiltration of gases and fluids with an efficiency 99.99997 percent with a particle size not greater than 0.05 μ, control of vibrations not above 0.2-0.5 μ in a broad spectral range, control and monitoring of the electrostatic component.

Such requirements are leading to the need for creating a special INDO design and to make allowance for interaction of the entire set of parameters in the earliest stages of designing and fabrication of INDO.

A leading American specialist in the field of ensuring cleanness in microelectronics production explains the entire specifics of the problem in the following way: "Checking on contaminants is an unending struggle with an enemy which saps all the energy at your command and you are stopped short. In order to make any progress you must move ahead twice as fast as you are moving."

With a changeover to the submicron region the problem of creating electronic devices and equipment is for all practical purposes transformed into the problem of creating super-VLSI chips using one crystal which performs all the required functions. This relieves the manufacturer of the equipment from the need for performing labor-intensive, poorly reliable assembly operations involving soldering and formation of interconnections. It must be emphasized once again that it is precisely the developers and manufacturers of radio electronic equipment who experience the principal technical-economic gain with a changeover to submicron technologies. Accordingly, even now in the initial stages of implementation of submicron technologies an acute problem which arises is the integration of the producers of VLSI chips and electronic radio equipment, organization of vertical scientific production structures, the working out and implementation of interbranch multisided programs.

In the near future it will evidently be necessary to reexamine the system for organizing and funding scientific research and design work in the branch. The first steps in this direction have already been taken and the program planning system is already demonstrating its effectiveness in realining electronics industry structures. Without question, in this structure submicron technologies will occupy a worthy place and will ensure a basis for developing a new class of VLSI chips determining the level of the scientific-technical and defense potential of Russia.

Project. Development of Infrastructure of Complex of Microelectronics Production Facilities

The program provides for the development of a complex of microelectronics enterprises in Zelenograd for the purpose of increasing the volumes and enhancing the efficiency of deliveries on the world market and satisfaction of the need of the Russian electronics industry for microelectronics items.

The developed and supplied microelectronics items will ensure the production of:

— new-generation TVs, including for high-clarity TV, digital and satellite TV;

— telecommunications equipment, including for digital automatic telephone offices, fiber optics and space communication lines and the cellular telephone network;

— microprocessor controllers for household appliances and machines, transportation and industry;

— special-order integrated circuits meeting the specifications of the client, which on the basis of standard (imported) microprocessors and memory circuits will make it possible to produce original Russian computers of a broad class;

— licensed production of microprocessors for military electronics.

Work To Be Done Within Scope of Project

Designation of Stages

1. Completion of setup of pilot lines. Beginning — 1994; End — 1995 Mastery of experimental production of integrated microcircuits with minimum size of element 0.8-1.0 μm. Development of 0.5 μm technology

2. Completion of setup of new plants. Beginning — 1994; End — 1996 Mastery of standard production of integrated microcircuits with minimum size of element up to 0.5 μm. Considerable broadening of exportation of integrated circuits.

Volumes of Production and Investments (Millions of Dollars)

	Year							
	1994	1995	1996	1997	1998	1999	2000	2001
Volumes of production:								
Pilot lines			38	52	65	72	110	118
Plants				28	121	186	250	332
Total			38	80	186	258	360	450
Investments:								
Completion of setup of experimental production (pilot lines)	54	10						
Development of technology	4	5	10	10	15			
Completion of setup of new plants	10	100	150					
Total	68	115	160	10	15			
Total recoupment will be achieved in 2001 according to the plan.								

Nauchnyy tsentr Scientific Production Concern Telephone: (095) 531-23-60 Fax: (095) 531-90-51

Project. Production of Functionally Complex Integrated Circuits

Broadening of production, introduction of industrial technology and production of VLSI chips.

VLSI chips constitute the elemental base of computer equipment, telecommunications and modern household electronic equipment. The large-scale production of VLSI chips in Russia will make it possible, with relatively low production costs, to supply with Russian peripheral items the produced computers, communication equipment, TVs, etc., including equipment produced under licenses of foreign countries. The attained high scientific-technical and production level of Mikron has made it possible to carry out extensive export deliveries, which in combination with data from constantly conducting marketing research is evidence of a stable sales market for VLSI chips in Russia and abroad.

The technical level of the VLSI chips planned for production according to this proposal is characterized by planning norms 0.8 μ.

Technical Specifications

Variety of VLSI chips: microprocessors, memory devices, controllers, semi-special order IS, TV and other microcircuits in wide use, a total of more typonominals on plates and in housings.

The technologic level of the planned clean rooms is classes 1 and 10.

Area of constructed clean production rooms — 2,500 m^2.

Diameter of processed silicon plates — up to 150 mm.

Basic technologies: complementary MOS (CMOS), bipolar CMOS (BiCMOS) structures.

Volume of production — up to 100,000 plates with VLSI chips annually.

Work To Be Done Within Scope of Project

- Completion of construction of clean production rooms.
- Fabrication acquisition and mounting of special technologic equipment.
- Setting up of industrial technology for production of VLSI chips.
- Planning and production of special-order and licensed competitive items.
- Preparations for and organization of production of VLSI chips and marketing network.

Times and Volumes

The production of VLSI chips can be initiated in 1996 and will increase by years:

in 1996 — 75,000 plates;

in 1997 — 90,000 plates;

in 1998 — 95,000 plates.

Funding

The approximate amount of investment required for implementing the work program will be 45 million dollars. Form of funding — advantageous credit for five years.

Cost Recovery Period

If the anticipated volumes of production are met the recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest will be the year 2000.

Mikron Microelectronics Scientific Research Institute, Zelenograd Telephone: (095) 535-15-09.

Project. Production of Functionally Complex Integrated Circuits

Implementation of the final stage in reconstruction of already existing and development of new production of integrated circuits based on submicron technologies competitive at the world market.

Supplying of developing Russian market with a modern elemental base, filling of existing export orders in the region of Southeast Asia (Singapore, Hong Kong, Taiwan, South Korea), and also in the countries of Europe and America (France, Canada, United States).

Production and development of microelectronic items specialized in following directions:

- dynamic and static RAM;
- microprocessor outfits;
- constant and electric reprogrammable memories;
- basic matrix crystals;
- calculators and electronic games;
- LSI chips for pacemakers;
- VLSI chips for special radio equipment.

The client is offered scientific-technical production in the form of basic submicron technology, produced VLSI chips of a wide variety, CADS and services for their introduction and use.

Brief description of the work to be done. Basic n-MOS and BiCMOS structures.

First stage — setting up of production line and realization of a basic technology for VLSI chips at level 1.2-0.8 μ. Line capacity — 120,000 plates (150 mm) annually.

Second stage — completion of construction and outfitting (jointly with Meisner-Wurst Company) of a plant for basic technology at the level 0.8- 0.5 μ.

Plant capacity — 240,000 plates (150 mm) annually.

Implementation Periods and Funding Amounts

First stage — 28.5 million dollars invested for implementation of project during period 1990-1994, required amount of investment — 15 million dollars.

	1995	1996	1997
Expenditures on development and construction, millions of dollars	15	-	-
Production of plates, thousands/year	80	120	120
Sales volume, millions of dollars	25	45.5	60.0
Payments to investor, millions of dollars	2.3	5.6	10.1

Second stage — 100 million dollars invested for implementation of project during period 1994-1999, readiness of building and supporting production structures 90 percent, required amount of investment 120 million dollars.

	1995	1966	1997	1998	1999
Development expenditures, millions of dollars	80.0	40.0			
Production of plates, thousands/year	-	150	240	240	240
Sales volume, millions of dollars	-	80	130	180	220
Payments to investor, millions of dollars	-	11.2	31.5	44.1	58.8

Angstrem Plant, Zelenograd Telephone: (095) 531-24-65

Project. Construction of Buildings for Clean Production Processes

Provision is made for the construction of production buildings for the organization of highly precise production work requiring special conditions with respect to air purity, maintenance of necessary parameters with respect to temperature, humidity and vibration by means of use of engineering equipment (air conditioners, pure air ducts, clean rooms, control and regulation systems) fabricated in the branch in conformity to a license of a West German company.

The field of application is; microelectronics, radio and instrument making, precision machine building, medicine, pharmacology and microbiology.

Technical Specifications

Projects have been developed for production buildings of two types: with installation of air preparation systems at the same level with the clean zone space in which the clean rooms are situated (structures of the Komplekt 1EGM type) and over clean rooms — in the intergirder space (structures of the Komplekt 2EG type).

The Komplekt 1EGM structure is a 1-2 story building with a total area 20,800 m^2 (area of clean rooms 3,900 m^2.

The clean zone measuring 54 x 72 m is located in the middle part of the building. An antivibration slab underlies the entire clean zone. For the purposes of efficient use of the clean zone space the grid of supporting pillars measures 18 x 18 m. The height to the bottom of roof structure is 12.45 m. Structures of the Komplekt 1EGM type are being built at the Mikron factory at Zelenograd and at other microelectronics enterprises.

At the Angstrem factory at Zelenograd, according to documentation prepared by the Meisner and Wurst Company, a two-story building with a total area of 23,800 m^2 (area of clean rooms — 3,700 m^2). The building measures 46.8 x 144 m (clean zone 46 x 86.4 m). The air-preparation equipment is located in the intergirder space above the clean rooms. An antivibration slab is situated beneath the clean zone.

Implementation of the projects for the construction of production buildings will make it possible to ensure the following parameters in the work places:

- Air purity — not more than 1 particle with a diameter of not more than 0.1 μ per 30 liters.
- Accuracy in maintaining temperature +/-0.1 K.
- Accuracy in maintaining relative humidity +/-3 percent.
- Rate of laminar air flow 0.45-0.55 m/s.
- Multiplicity of air exchange 400-600 times/hour.
- Amplitude of range of vibrations of frequencies 5-40 Hz not more than 0.25 μ.

Work To Be Done Within Scope of Project

Completion of construction of facilities for the Mikron, Angstrom and Physical Problems Scientific Research Institute at Zelenograd, SEMZ in Solnechchnogorsk, Aleksandova, St. Peterburg, Novgorod. Plans call for the construction of facilities in Novosibirsk, Voronezh, Ulyanovsk, Fryazino and Pavlovskiy Posad.

Times and Volumes

Within the scope of the Russian State Program for the Development of Electronics Technology provision is made for the construction of 16 such plants. The amount of investment under the project as a whole is estimated at 7 billion 750 million dollars , including by years:

1994 — 400 million dollars;

1995 — 255 million dollars;

1996 — 1,300 million dollars;

1998 — 2,790 million dollars;

1999 — 345 million dollars;

2000 — 835 million dollars;

2001 — 825 million dollars.

Funding and Cost Recovery Period

Funding is to be by investments and loans.

The approximate time for recovery of costs is 2 years.

Moscow State Superconductor Institute, Moscow

Project. Development of CADS Software for Special-Order IS in Open Standards

Plans call for the development of an integrated CADS for special order MDS, bipolar and BiCMOS integrated circuits of the following classes: analog, digital-analog and digital. The applied analog support will be integrated into a unified system on the basis of a specialized framework and the following open standards: Unix operating system, X Window System network multiwindow system, OSF/motif user's graphic interface.

Technical Specifications

Functioning with the INTEL and SPARC media work stations with a productivity not less than 15 MIPS and a RAM capacity not less than 32 Mbyte.

The complexity of the planned IS is limited only by the resources of the existing work station.

Support of the principal standards used in the world in the designing of IS: Verilog, Spice, XNF, EDIF, GDS II, etc.

Continuous verification of the project at all stages.

Well-developed techniques for planning libraries.

Close relationship to technology for fabricating the IS due to computation of parameters of models of elements of transistor level and the combination of their topologies on the basis of physical-topologic models of instruments.

Well-developed techniques for modeling analog and digital-analog IS.

Support of planned libraries of Western fabricators of IS.

Work To Be Done Within Scope of Project

- Editor of electric circuits.
- Program packages for modeling of static mode, static characteristics, transient processes and frequency characteristics of digital-analog bipolar, MDS and BiCMOS IS:

editing and interactive analysis of analog signals,

universal program for analog modeling (includes Spice possibilities),

key modeling of CMOS IS,

identification of parameters of models of transistors relative to volt-ampere characteristics.

- Program package for logic modeling:

•editing and interactive analysis of signals,

•logic modeling,

•time verification,

•compilation and debugging of models of IS elements.

- Program for multilevel mixed modeling.

- Topology editor at polygons level.
- Program package for topology synthesis by standard elements method:

planning of crystal,

placement and alinement,

manual editing of topology under control of planning norms and list of connections.

- Program package for topology verification:

checking of design-technologic restrictions,

checking of electric rules of designing,

extraction of topologic parameters,

extraction of parasitic resistances,

checking of correspondence of topologies and electric circuit.

Time Required for Project Implementation

Obtaining a commercial version of the CADS will require approximately 36 months assuming a work force of 60 specialists.

Funding and Cost Recovery Period

The full amount of funding required for the project is 32,000,000 dollars, including for the acquisition of computers — 450,000 dollars.

The CADS proposed for development is oriented on small- and medium-size companies planning IS based on inexpensive work stations of INTEL and SPARC media.

It is proposed that the price of one license of a fully functional CADS, developed within the scope of this project, will not exceed 70,000-100,000 dollars, which is three or four times cheaper than systems from Mentor Graphics, Cadence Design Systems and Compass Design Automation. In addition, this CADS should operate using far cheaper equipment than the systems of competitors. For example, whereas the recommended volume of the on-line memory necessary for CADS operation from Mentor or Cadence is 64-95 Mbyte, for the CADS developed in Russia it is 32 Mbyte.

Thus, the sale of 35-45 CADS licenses is required for full recovery of project costs.

Special Requirements

For the successful development of a competitive CADS it is desirable that a Western partner participate for the purpose of: — involvement in the development process of one or more marketing companies specializing in the market for software for the planning of IS; — providing Russian programmers with the necessary documents (primary with respect to standards) and the acquisition of the project libraries which must be used in putting the CADS together.

Electronic Materials Scientific Research Institute and Mikron factory, Zelenograd Telephone: (095) 536-81-48.

Project. Development of High-Precision Technology for Plasmochemical Etching and Stimulated Processings at Cryogenic Temperatures

New technologies characterized by a high selectivity and anisotropic properties, intended for development and production of super VLSI chips of the DOZU 64M class.

Technical Specifications

Controllable energy effects when conducting structure formation processes. Selectivity and anisotropy — 10-50 Precision, percent — +/-2 Thickness of layers and depth of etching, μ — 0.01-5 Localness of etching, μ — 0.5 Materials of layers: silicon, metals, dielectrics

Work To Be Done Within Scope of Project

— development and optimization of plasmochemical reactor with cryogenic cooling of substrate, fabrication of mock-up of molecular cleaning outfit;

— development and fabrication of experimental copy of outfit for plasmochemical etching and final cleaning;

— development of technology for plasmochemical cryogenic etching and stimulated cleaning processes and checking in experimental production;

— development of basic technology and organization of standard production of equipment.

Funding and Cost Recovery Period

The program is being implemented during the period 1995-1997.

The required amount of funding will be 3 million dollars.

The form of funding is an advantageous loan for 3 years.

The proposed need for equipment and technology is 30-40 outfits per year. Export deliveries to the CIS countries, China and Korea are possible.

Implementation of the program will ensure full recovery of project costs and repayment of loans in 1988.

SUBMIKRON Scientific Research Institute, Zelenograd
Telephone: (095) 536-15-93, 536-48-59

Project. Industrial Strategic Technologies

The establishment of a center for submicron technology for microelectronics, micromechanics, nanotechnology and medicine on the basis of the small SKN-600 superconducting synchrotron electron accumulator.

The established Center is to have an SKN-600 accumulator, ion beam and laser apparatus and diagnostic equipment.

The Center plans the production of new-generation VLSI chips, MSI chips and memories with a structural broadening 0.1 μ and a memory volume up to 1 Gbit. Such microcircuits can be obtained only using X-ray lithography using the synchrotron radiation of the SKN-600 accumulator.

The development, fabrication and delivery (including abroad) of equipment for accelerators and colliders, especially superconducting cryogenic magnets for a field up to 7 teslas is possible.

With use of LIGA technology provision is made for the fabrication of miniaturized sensors and sensors of vibrations, accelerations and pressures, microgears, micromotors and microdrives — the latest items in the micromechanics field, the use of which includes modern medicine, microoptics, aviation, automobile and aerospace branches.

Technical Specifications for SKN-600

Electron energy, MeV — 600

Injection energy, MeV — 60

Orbital perimeter, m — 10

Radius of rotation, cm — 33

Magnetic field, kgauss — 60

SI wavelength, A — 8.6

Current storage circuit, mA — 300

Number of SI output channels — up to 21

Productivity with exposure of printed circuit boards with diameter of 200 mm per channel / boards/hour — 20

Work To Be Done Within Scope of Project

- Completion of construction-assembly work, including the SKN-600 infrastructure.
- Carrying out experimental research and design work for investigating the technical-physical parameters of the outfit, developing diagnostic systems, vertical steppers, systems for cryosupport, control and protection
- Startup of SKN-600 in working technologic mode, and output of SI beams to receiving lithographic stations stabilization of the orbit of electrons
- Preparations for and organization of production of items in microelectronics and micromechanics industries
- Metrologic and certification testing

Times and Volumes

If investments suffice the construction of the Center can be completed in 12-16 months.

The predicted annual volume of production (with four SI output channels) will be (in units):

processed plates with diameter 200 mm — 50,000

silicon vibration sensors — 120,000

silicon acceleration transducers — 130,000

medical micromotors — 10,000

micromotors for monitoring and control systems — 11,500

thin-film planar components — 1,000

superconducting cryogenic magnets for 7 teslas — 24

medical microlasers — 200

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the Program will be 12 million dollars. Form of funding — advantageous loan for 3 years.

It is planned that after initiation of Center operations under the technologic program the costs will be recovered due to submicron lithography of printed circuit boards and also due to the delivery of precision micromechanical transducers, accelerator-collider equipment and cryogenic magnets. The time for recovery of the investment will be two years after the Center is put into operation.

High Temperatures Scientific Research Institute imeni Vekshinskiy, Moscow

Project. Development and Initiation of Production of Chip Cards for Broad Application

The plastic dip map is intended for the registry, readout and long-term storage in a built-in microcircuit of an electrically reprogrammable data memory of the disseminator and client, which makes possible their use

as part of a group of technical devices for impersonal calculations in an electronic payments system.

The chip card has a system of passwords for the manufacturer, disseminator and client and ensures protection of stored data against unauthorized access for both the registry and readout of information which is superreliable in comparison with magnetic cards.

Technical Specifications

The plastic chip card corresponds to the standard ISO-7816, that is, measures 85.7 x 54.0 x 0.8 mm, weight not more than 20 g.

Work To Be Done Within Scope of Project

— mastery and standard production of foreign technology for assembly of plastic chip cards;

— development and standard production of chips of different information capacity;

— acquisition of technologic equipment for assembly of chip cards;

— development of metrologic equipment;

— construction of an infrastructure for use of chip maps.

Times and Volumes

The production of chip cards can be initiated beginning in mid-1995 and will increase by years (thousands of units): 1995 — 500; 1996 — 2000; 1997 — 12,000.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the project, with allowance for work done, equipment inventory and work areas will be 4 million dollars.

Form of funding — an advantageous loan for 2 year.

If the stipulated volumes of production are met the total recovery of the investment will be attained 2 years from the time of the investment. The time for full repayment of the loan with interest is the first half of 1997.

SUBMIKRON Scientific Research Institute, Zelenograd
Telephone: (095) 53648-59, 536-62-35

New Generation of Electronic Equipment Items for Extremal Operating Conditions

I. G. Lukitsa, V. G. Malinin and Yu. N. Torgashov

In addition to enterprises developing military equipment and arms, nuclear power production facilities, the aerospace complex, as well as the automobile, shipbuilding, chemical, oil and gas and medical industries and railroad transportation, when there is a need not only for radiationally resistant instruments, but also instruments operating at temperatures up to 500°C, with exposure to strong electromagnetic fields, aggressive gases and fluids and under mechanical loads, are now among the number of users of electronic equipment for extremal operating conditions. The problem of ensuring prolonged operability (from tens to hundreds of thousands of hours) of equipment under conditions of constantly operative low-intensity radiations, temperature and electromagnetic fields (nuclear power plants, space vehicles, geothermal holes, etc.) is moving to the forefront.

The dominant technology now ensuring the development of radiationally resistant integrated circuits with a maximum resistance to radiation exposures and low intensity of failures under the impact of heavy charged particles of cosmic radiation is the silicon on sapphire (SOS) technology. However, the high cost of sapphire and the low percentage of yield of suitable items due to the formation of defects in the sapphire substrate and at the silicon-sapphire interface considerably limits the possibility of silicon on sapphire technology.

SOI technology (silicon on insulator, is the insulation of integrated circuit elements by the characteristic dielectric SiO_2) makes possible a multisided solution of the problem of a further decrease in the size of elements and increase in the density of integration and speed, a minimizing of parasitic effects (leakage currents, capacitive couplings, noise, impulse accelerations, short channel effects), substantially increases resistance to radiation and heat and simplifies the technologic process and the process of designing circuits.

In addition, the integration process is simplified when fabricating joint bipolar and unipolar integrated circuits, as well as formation of powerful and high-frequency monolithic integrated circuits.

SOI technology also has unique possibilities for the formation of 3-dimensional integrated circuits, affording fundamentally new possibilities for computer and information equipment when processing signals in thousands of channels and also solution of artificial intellect problems.

It is equally important that the technology for the production of SOI integrated circuits can be realized with the maximum use of the technology existing in the branch for the fabrication of integrated circuits using three-dimensional silicon and the results of work done under programs and projects in the submicron technologies field.

The Elekronstandart Regional Scientific Research Institute, in collaboration with leading enterprises of the branch, has developed a many-sided purposeful program "Development of a New Generation of Radiationally Restistant Microelectronics Items on the Basis of the 'Silicon on Insulator (SOI) Technology'" directed to solution of problems involved in solution of problems

involved in a radical iacrease in resistance to radiation and heat, functional complexity and speed of Ic amd ISI chips by the development and industrial introduction of SOI technology.

Leading enterprises of the electronics industry, Academy of Sciences and institutions of higher education having scientific-technical development work in the SOI technology field have been enlisted in the implementation of the program.

The many-sided purposeful program includes studies closely related to one another and directed to:

- development of an industrial technology for forming SOI plates for different purposes by the SIMOX, WB and MBEPOS methods;
- creation of special technological equipment (ion implanter, high-temperature ovens, equipment for precision processing of plates, etc.) and control-measuring equipment for implementing a technology for SOI plates;
- development of processes and equipment necessary for the adaptation of the production of SOI for LSI chips, IC;
- conducting of technologic and instrumental development work on the formation of basic elements of SOI LSI chips;
- research on development of VLSI chips, creation of a new elemental base, solution of vertical integration problems (3-dimensional LSI chips) and resistance of instruments to radiation;
- development of promising metallization, assembly and encasement technologies;
- development of exoerimental SOI VLSI chips, IC for different functional purposes.

For memory circuits (RAM, ROM) a capacity up to 1-4 Mbit and a speed up to 20-40 ns have been attained, radiation-resistant ROMs with electric clearing of a capacity up to 1 Mbit and with time storage of information up to 10 years. In the field of microprocessor circuits the capacity will be increased to 32-64 bit with a working frequency up to 80 MHz, as well as basic matrix crystals with a number of gates up to 10^5 elements/crystal with an audio frequency up to 150 MHz. Precision and high-speed digital-to-analog and analog-to-digital converters with digits up to 12-16 bit, high-voltage IC with a voltage up to 1,000 V and a current up to 10A, high-voltage switching matrices, etc. The instruments will correspond to operational characteristics with respect to radiation resistance $F_p = 10^{14}$- 10^{15} n/cm², $D_\gamma = 10^6$- 10^7 rad, maximum working temperature 250°C, useful life 200,000 hours, durability 25 years.

In addition to vigorous development of SOI technology, foreign companies on orders from the nuclear power industry, aerospace complex and automobile industry are conducting work on developing a new generation of the elemental base of microelectronics for extremal operating conditions (working temperatures up to 500°C, radiation fields $F_p = 10^{15}$ n/cm², $D_{\gamma = 10}{}^{7\text{-}10\theta}$ rad0 on the basis of nontraditional wide-band materials (silicon carbide, silicon nitride, etc.).

Taking into account the priority of Russian research in the field of synthesis and microtechnology of these materials, in tne work program up to the year 2000 in order to ensure the development of electronic equipment items for extremal operating conditions a series of work projects are foreseen for creating, including by he radiation processing methods, of materials and epitaxial structures of silicon carbide, gallium phosphide and gallium arsenide and on their basis discrete-semiconductor instruments and integrated circuits with working temperatures up to 500°C with a radiation resistance level 10^{15}n/cm².

The reliable operation of special equipment also is ensured by its resistance to the influence of strong electromagnetic fields (SEMF), which may have both a pulsed amd a continuous character.

The Council of the European Economic Community in 1989 adopted a resolution according to which the electronic systems produced in countries of the community must have an "adequate level of built-in resistance to electromagnetic interferemce". The international standards IEC801 were developed for this purpose.

An increase in resistance and reliability of the items and equipment under conditions of exposure to SEMF is being attained in two directions: development of items (transistors, integrated circuits) wich incorporate protective elements and the development of special protective devices (voltage limiters, varistors, gas dischargers, etc.) for protection of the circuits of electronic radio equipment.

Project. Development of Technology for Fabricating Electronic Equipment Items

Development of a new generation of electronic equipment items with high resistance to radiation and heat and increased resistance when exposed to strong electromagnetic fields.

Technical Specifications

Increase in: degree of integration from 10^4 elements/crystal to 10^8 elements/crystal; speed from 150 ns to 0.01 ns; maximum working temperature from 125°C to 500-800°C; radiation resistance from 10^{13} n/cm² to 10^{15}-10^{18} n/cm²;

Active lifetime from 100,000 hours to 250,000 hours.

Limiting voltages: maximum from 5×10^3 to 4×10^4 V, minimum from 15 to 4 V

Work To Be Done Within Scope of Project

- Development of industrial technologies for production of electronic equipment items for extremal operating conditions.
- Development of special technologic equipment.
- Research work on and development of methods for predicting resistance and reliability of electronic equipment items with long lifetime with exposure to radiation fields, high temperatures and electromagnetic fields.
- Development of methods for rejecting radiationally unreliable items during production stage.
- Conducting instrument development work for formation of functionally complex resistant items for different purposes (VLSI chips, high-voltage integrated circuits, integrated circuits with built-in protection, protective devices, microtransducers, etc.).
- Preparations for and organization of production.

Times and Volumes

The development and industrial introduction of technologies and special technologic equipment with be accomplished in 1995-1997.

The development and production of radiation- and heat-resistant memory devices with a capacity up to 4 Mbit and speed up to 20 ns, magnetic memory with capacity up to 64 bit with a working frequency up to 80 mHz, BMK with number of rectifiers up to 10^5 elements/crystal with delay time 0.3 ns per element, 16-digit digital-to-analog converters-analog-to-digital converters, precision memories, high-voltage (up to 1,000 V) integrated circuits will be accomplished during 1997-1999.

Funding

The approximate amount of investment required for implementing the work program will be 42.5 billion rubles (about 10 million dollars).

Form of funding — appropriations from the state budget.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 2000.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

Microwave Electronics — High Scientific Input and High-Technology Branch of Electronics Technology

S. I. Rebrov, General Designer, doctor of technical sciences, professor

In modern electronics, together with such massive large-series fields, as, for example, microelectronics, determining the scientific-technical progress of most economic branches, there are unique technical fields, as usual, those with the highest scientific input and at the highest technologic level, intended for use in precision branches of industry and military technology. This combination of massive and unique technical fields makes modern electronics the principal basic branch of the economy.

One of these most important unique fields is microwave electronics, the electronics of superhigh frequencies, determining the development of modern military technology, the technologies for the transfer of information and communication, also exerting an enormous influence on progressive energetics, development of medicine, productivity of agriculture and solution of ecologic problems.

Work in the field of microwave electronics in the indicated fields of technology and electronics are represented in the Russian State Program for the Development of Electronics Technology in the form of an interrelated complex of projects, the basis for which is a subprogram for basic and practical research.

The subprogram for basic and practical research takes in the further development of vacuum microwave electronics in the range of medium and low powers, submicron technology of monolithic microwave microcircuits, functional electronics and use of the properties of high-temperature conductivity (HTC). By developing the scientific stock of completed research in the mentioned fields, this subprogram will determine the technical level of practical development of development work for the next 10 years.

Participants in the subprogram are all the branch scientific research institutes and design bureaus with the involvement of organizations of the Academy of Sciences of the Russian Federation. The leading organization heading and coordinating implementation of the program is the Istok State Scientific Research Institute.

Dual- and Special-Purpose Complex Programs

The role of microwave electronics as a basis for military electronic components is difficult to overevaluate. The superiority of the tactical-technical characteristics of the S-300V, S-300PM, Tor and other air missile complexes, demonstrated at international exhibitions in 1990-1994, was ensured primarily by the outstanding systems engineering solutions serving as a basis of constructing equipment and the leading level of microwave electronic components.

In the microwave electronics field provision is made for implementing three principal complex-purposeful projects for special equipment, radar, communications technology, navigation and television up to the year 2000.

Chief manufacturer: Istok.

- for traveling wave tubes in the ranges 2-35 GHz with output powers 0.25-50 kW (working frequency band 700,1,000 MHz, amplification factor 30-35 dB, 50 dB);
- amplifying klystrons in ranges 0.5-150 GHz with output powers 0.002-1 MW (working frequency band 100-200 MHz, amplification factor 35-50 dB);
- gyroinstruments in ranges 15-300 GHz with output powers 0.1-1 MW.

The developed instruments are intended for radar technology and military communication and navigation systems.

Chief manufacturers: Titan and Istok.

The project for monolithic one- and multifunctional microwave microcircuits provides for the creation of a wide variety of monolithic microwave microcircuits based on submicron and SMIF technologies in the directions:

- basic matrix crystals;
- fixed and tunable oscillators operating in the ranges 1-300 GHz, dividers, multipliers, mixers and frequency converters for receivers and frequency synthesizers;
- wide-band and resonance power amplifiers operating in ranges 1-100 GHz;
- input resonance and ultrawide-band amplifiers operating in the ranges 0.5-100 GHz;
- protective and switching devices.

Combinations of the mentioned microcircuits on the basis of monolithic and hybrid technologies are making it possible to proceed to multifunctional microwave supercomponents with a considerable, by tens of times, reduction in weight, size and cost of equipment, especially for receiving-transmitting modules for phased antenna arrays, microwave receivers. Wide-band amplifiers of intermediate frequencies and precision synthesizers.

The new generation of microwave electronic components is intended for all types of military electronic radio equipment for the purpose of a substantial decrease in mass, size, cost and broadening of functional capabilities.

This project is based on dual-purpose technologies and the results of the work, like the created electronic components, may find broad use in many branches of industry and household electronics.

Principal manufacturer: Istok.

The project for microwave electronic components for communication systems, radio surveillance and noise generation provides for development work on:

- ultrawide-band TWT with a working band up to 2 octaves and with a power 0.5-3 kW in the ranges 1-40 GHz;
- solid-state electronic components for different purposes, in particular reference and tunable oscillators, mixers and frequency converters;
- wide-band input and powerful solid-state amplifiers;
- acoustoelectronic instruments and devices operating on magnetostatic waves for processing signals, etc.

The conducting of work in the mentioned directions is interrelated to implementation of the two preceding projects for the purpose of maximum standardization of the results.

[Note. materials on the status of work in the field of military electronic components also is contained in the article "Military Electronics in Russia," Bonn, MILITARY TECHNOLOGY, No 5, 1993.]

Principal manufacturers: Almaz and Istok.

The implementation of projects for electronic microwave special-purpose components as well as development of the microwave elemental base for general industrial and household purposes, involves implementation of the special-purpose practical projects described in Section 3.

General Industrial and Economic Projects

The principal stimulus for the development of these projects was the conversion character of the Russian State program for Development of Electronic Technology. At the time it was drawn up there were virtually no dual technologies in microwave electronics. Beginning with 1990-1992 a broad search was undertaken for finding new fields of application of microwave components, different kinds of microwave equipment in the form of final goods production. Microwave electronics enterprises are carrying out 3 major projects for general industrial purposes.

Project for developing microwave electronic equipment items, devices and stations based on them for establishing communication systems (principal manufacturer Istok, manufacturers Titan, Almaz, Svetlana) provides for development in the following directions:

Combined microwave devices and electronic components for communication satellites and information systems:

- standardized receiving-transmitting modules;
- elemental base for satellite communication surface components and onboard stations (see Table).

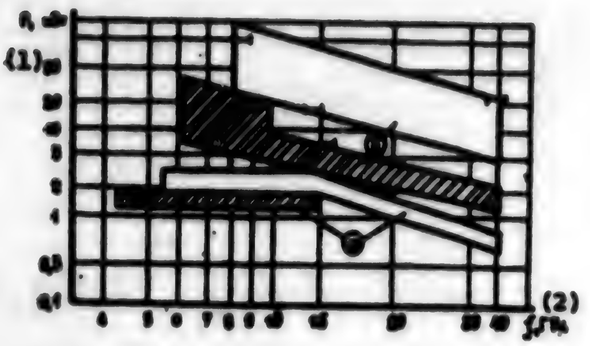


Fig. 1. TWT for communication systems (a) and multimode multifunctional TWT (b). Symbols: Diagonal shading — development work: Working frequency band — 1,000 MHz Amplification factor — 30-35 dB. Efficiency — 25-30 percent. Clear area — research: Working frequency band — 700-1,000 MHz. Amplification factor —50 db. Efficiency — 20-35 percent. Filling factor — 0.3-0.1.

1. p, kW 2 f, GHz

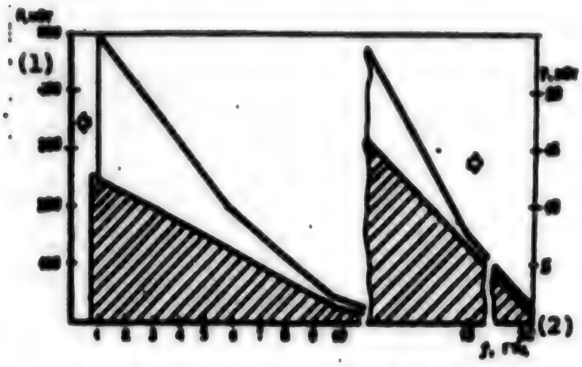


Fig. 2. Continuous action amplifying klystrons. Symbols: diagonal shading — development work; clear area — research. Working frequency band — 100-200 MHz; Amplification factor — 35-50 dB.

1. P, kW 2. f, GHz

No	Frequency range, GHz	Output power, W	Efficiency, percent	Maximum voltage, kV	Weight, kg
1	1.4-1.6	20	30	2.5	2.0
2	3.4-4.2	18	45	2.5	1.0
3	3.4-3.9	40	50	2.8	3.4
4	3.4-3.9	80	50	2.8	3.4
5	4.4-4.6	60	36	3.3	3.4
6	7.25-7.75	20	45	3.7	1.0
7	10.8-13.6	6	30	3.0	0.7
8	10.7-13.7	20	42	3.5	1.0
9	11.7-12.5	300	45	8.0	4.0
10	20.0-21.4	20	40	7.0	2.0

Electronic components for TV and microwave sounders operating in the near range:

- microwave instruments and combined devices for all types of transmitting TV stations;
- equipment for reception of satellite TV signals and air-cable information networks;
- Doppler microwave sounders operating in the near range for autos and trucks, railroads, study of the properties of materials, etc.

Amplification factor — 40-55 dB Working frequencies band (multifrequency mode) — 1-5 percent TWT useful life — 50,000-100,000 hours

Digital radio relay stations and electronic components for them:

- radio relay digital communication stations;
- mobile journalistic radio relay stations (of US Intelsat and Japanese TBS types);
- stations for digital transmission of data for local computer networks;
- elemental base for main radio relay lines.

The radio relay equipment represented in the program is at the level of modern Western development work (Teletra Espanola - SHD -30, Philips TRT - 2000), but has broader functional capabilities.

Radio and telephonic communication devices:

- personal and automobile multichannel radio stations;
- cordless telephone and radio telephone devices and their electronic components.

Implementation of project — 1994-1997, initiation of production — 1995.

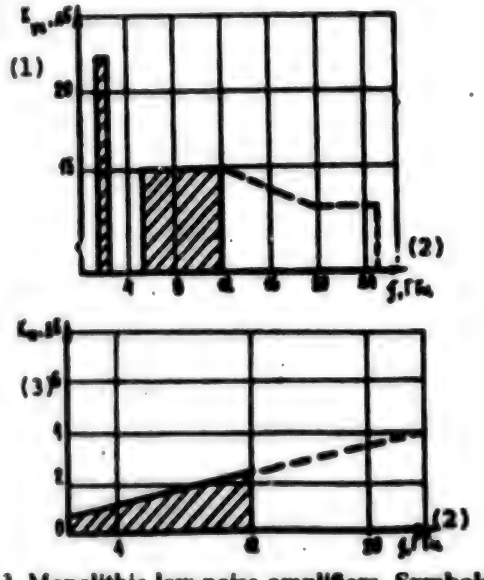


Fig. 3. Monolithic low-noise amplifiers. Symbols: diagonal shading — development work; clear area — research. Working frequency band — 10-15 percent. Range of working temperatures — from -60 to 85°C. Dimensions — 7.5 x 13 x 2 mm. Weight — 1 g.

1. $K_{ус}$, dB; 2. f, GHz 3. $K_{ш}$, dB

Project for developing highly productive equipment and progressive resource-conserving clean technologies on the basis of microwave energy and their introduction into the Russian economy (principal manufacturer Titan manufacturers Istok, Phuton Special Design Bureau, Kontakt Special Design Bureau, Central Scientific Research Institute for Automation) provides for the following work directions:

Development of microwave equipment and technology for food and processing branches of the agroindustrial complex.

Development of microwave equipment and technology for the fishing industry (complex reworking of hydrobionts, production of food and fodder products), which affords a possibility for obtaining additionally about 100,000 tons of finished products annually.

Development and organization of large-series production of microwave household and industrial ovens — up to 1 million units annually.

Development of equipment and low-waste energy-conserving technologies for the processing of wood, ceramics and other construction materials on the basis of microwave heating with a saving of energy expenditures by a factor of 1.5-2 and up to 16 million m³ of wood.

Development of standardized series of powerful vacuum instruments and power sources for equipment developed in the above-mentioned directions (about 10 units of equipment with a radiation power from 5 to 100 kW at frequencies 915 and 2,450 MHz).

Development and introduction of standardized systems for automatic monitoring and control of equipment and technologic processes.

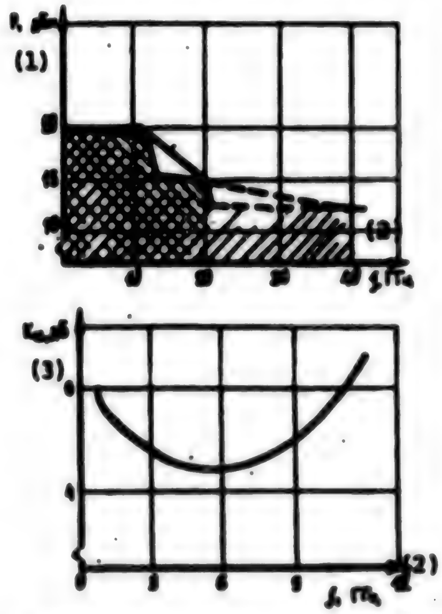


Fig. 4. Monolithic wide-band amplifiers. Symbols: Cross-hatching — frequency range — 0.3-12 GHz. Amplification factor — 5 dB. Diagonal hachuring — frequency range 2-18 GHz. Amplification factor — 10 dB.

1. P, dBm 2. f, GHz 3. $K_{ш}$, dB

Implementation of project — 1994-1998 with recovery of expenditures in 1998.

Project for developing and organization of production of flat vacuum screens with matrix autoemission cathode (manufacturers: Istok, Volga, Physical Problems Scientific Research Institute).

This project is a component part of the many-sided projects for information display equipment, chief manufacturer: Platan. the participation of microwave electronics enterprises in this project is related to many years of experience in work in the fields of vacuum technology, autoemission and precision technology of monolithic microwave microcircuits. The directions in the work are:

Development of monochromatic screens and displays based on them with diagonals 10 and 16 cm (1994-1996).

Development of full-color screens with diagonals 16 and 25 cm (1995- 1998).

Construction of pilot lines and organization of production of flat vacuum screens and miniTVs based on them (1996-1999).

In addition to the three industrially oriented projects mentioned above, microwave electronics organizations are implementing a project for developing electronic instruments and devices based on high-temperature conductivity (HTC) of a scientific and practical character. This project provides for the development of HTC materials with improved properties, development of vacuum microwave instruments with HTC magnetic systems, microelectronic microwave instruments and photodetectors based on HTC.

The development and production of monolithic microwave microcircuits is affording new possibilities for the use of microwave electronics for the introduction of near-range radar sensors intended for use in the most different fields of human activity. The set of appended near-sounding projects first of all covers solution of urgent transportation problems.

A considerable amount of work is provided for in the field of medical equipment for different purposes (diagnosis, general therapy, surgery).

The implementation of the program and the presented projects will make it possible to maintain the scientific and production potential of Russian microwave electronics and will strengthen its leading position in the world and will meet the needs of defense and the Russian economy with the affording of broad possibilities for any foreign partners in carrying out joint work, deliveries of high-quality and inexpensive microwave components, licenses for high technologies in this field and equipment produced on their basis.

Project. Development of New Generation of Powerful Low-Voltage Amplifying Klystrons, Traveling Wave Tubes and Gyrotrons

Provision is made for organizing the production of a new generation of vacuum microwave instruments: amplifying klystrons, traveling wave tubes and gyrotrons characterized by high power with considerably reduced power voltages due to the use of original designs. Fields of application:

— surface-, sea- and space-based powerful radar stations for distant- detection, target designation and guidance

— onboard radar targeting complexes, guidance control and distant surveillance complexes;

— different kinds of airfield sounders;

— noise generation stations;

— communication equipment of all types and purposes;

— linear accelerators of charged particles and plasmatrons with different energy levels;

— equipment for scientific research in field of controllable nuclear reactions, biology and medicine.

Technical Specifications

Type	Output power, kW	Frequency, GHz	Band width, MHz	Amplification, dB	Efficiency, percent
Amplifying klystrons					
pulsed action	100,000-20 (relative pulse duration 50-100)	0.5- 90	200-400	30-50	40-50
continuous action	1,000-0.1	0.5-90	100-200	35-50	35-45
Traveling wave tubes					
pulsed and continuous action	100-0.05(relative pulse duration 3-50)	0.4-40)	400-800 1-2 octaves	40-50	25-35
Gyrotrons and gyroamplifiers	0.1-2	15-300	2,000		

One of the promising directions in a considerable (by a factor of 5-10) increase in output powers with a working frequency band of 1-2 octaves is the development of OBV with high-temperature superconducting magnetic systems.

The use of the latter for the purpose of "freezing" of the electron beam also will make possible a substantial increase in the efficiency and limiting frequencies of powerful microwave instruments.

Funding and Cost Recovery Period

Development work on the basic designs of the instruments for covering the mentioned frequency ranges and powers,with allowance for the construction of test stands, will require 8-10 million dollars during the period 1995-1998.

The anticipated period for the recovery of costs will be from 2 to 3 years when organizing joint development work with partners in Western Europe and the United States.

Toriy State Scientific Production Enterprise Fax (095) 332-54-66

Istok State Scientific Production Enterprise Fax (095) 465-86-86

Almaz State Scientific Production Enterprise Fax (845) 21-02-57

Descriptions of the design features and technical directions in work on powerful microwave instruments were reported at international MMTs symposia of the IEEE in the United States (June 1991, Boston: June 1992, Albuquerque; June 1993, Atlanta). There are papers in the IEEE Transactions, 1992, digests MTTS 1991, 1992, 1993, and in the journal MILITARY TECHNOLOGY, 5/93, Bonn.

Project. Development and Organization of Production of Widely Applicable Monolithic Integrated Instruments, Single- and Multifunctional Microwave Microcircuits

The project provides for development of a new generation of solid-state microwave instruments and devices based on monolithic technology and pilot lines for their production. Fields of application:

- radar equipment of all types and all purposes;
- precise guidance systems;
- receivers operating in microwave and EHF ranges;
- radar and communication equipment frequency synthesizers;
- high-clarity TV systems;
- near sounding as safety signaling equipment and devices;
- control-measuring equipment and scientific research instruments, etc.

Evaluation of efficiency of use of new generation of monolithic microwave instruments and microcircuits in microwave equipment

Equipment type	Improvement in indices, times		
	Size	Weight	Cost
Precise guidance equipment	20	15	10
Radar	5	3	5
Communication	10	3	2

Technical Specifications of Principal Classes of Microwave Circuits

- Tunable generators up to 110 GHz with tuning band up to 1 octave (current-free mode from controlling electrode).
- Low-noise amplifiers up to 60 GHz (working band 10-15 percent, noise factor 0.5-4 dB).
- Wide-band input amplifiers 0.1-40GHz (noise factor less than 6 dB in band 1-12 GHz).
- Special-order power amplifiers operating in range up to 60 GHz with working band 10-15 percent, high power from 0.5 to 10 W.
- Frequency dividers, multipliers and converters operating in frequency ranges up to 300 GHz with different values of conversion factors.
- Switching, controlling and protective devices in ranges up to 60 GHz with different characteristics with respect to working band and power.
- Multifunctional microwave microcircuits based on above-mentioned classes for receiving and

transmitting microwave equipment, especially receiving modules, frequency synthesizers, receiving-transmitting modules for active FAE and others.

Funding and Cost Recovery Period

With allowance for the expenditures made up to 1994 the investment for development work for supplementing parametric series of basic designs of microwave microcircuits and organization of pilot lines for their production will be 10-15 million dollars; more than 70 percent will go for the organization of production.

In the event of deliveries only in the Russian market the cost recovery period may increase from 3 to 5 years. The cost recovery period may be reduced by realization of the projects described below for final goods production in the form of radar sensors for near sounding and communication equipment for the organization of production at electronics industry enterprises.

Istok, Fax (095) 465-86-86 Almaz State Scientific Production Enterprise, (845) 214-02-57

Project. Powerful Microwave Instruments and Standardized Energy Sources for General Industrial and Economic Use

The project provides for development of:

Standardized series of sources of microwave energy and a parametric series of generators and amplifiers for them;

Standardized source of microwave energy, structurally designed in the form of a single self-contained unit — a microwave instrument with sources for its power supply, cooling and protection;

Parametric series of powerful magnetrons and klystrons, standardized power sources based on them and organization of production for highly productive equipment and new progressive resource-conserving technologies for the processing of products in the agroindustrial complex, fish and lumber industries (see projects described below).

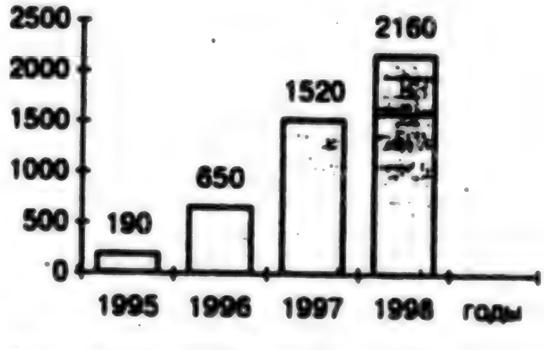
Technical Specifications

Parametric Series of Magnetrons and Klystrons

Type	Range, MHz	Power, kW						
		2.5	5	10	25	50	100	30
Magnetron	915	+	+	+	+	+	+	+
	2,450	+	+	-	-	-	-	-
Klystron	2,450	+	+	+	+	+	-	-

The efficiency of the magnetrons is from 60 percent for powers 5 kW or less and up to 80 percent for 25 kW or more.

The cooling is liquid other than for instruments with a power 2.5 kW (air)The lonevity of the magnetron generators averages 5,000 hours. Provision is made for the possibility of increasing it to 10,000 hours. Development work on energy sources for klystrons is dictated by the need for a further increase in longevity to 20,000 hours or more, which also is provided for in the development work described. Nevertheless, the power sources for klystrons is more expensive and complex in operation, which warrants continued use of magnetron sources. The number of nominals and different radiation frequencies is dictated by the requirements of technological processes for the processing of materials of the most different properties and structures; brick, hard species of wood, grain crops, vegetables, fruits, meat, fish and various sea products.



1. Times and Volumes 2. Years

The diagram shows the production of energy sources of all types. The number of microwave instruments necessary for production and operation is greater by a factor of 1.8-2.2.

This project does not take into account the production of everyday magnetrons, assigned to the project for household microwave ovens.

Funding and Cost Recovery Period

The investment necessary for developing a standardized eries of sources of microwave energy and instruments for combining them is 8 million dollars during the period 1994-1998.

The project will pay for itself in three years after the commencement of standard (more than 500 units) production and assunes the implementation of the projects described below for the processing of agricultural products, fish, wood and construction materials.

Toriy State Scientific Production Enterprise Fax (095) 332-64-66

Istok State Scientific Production Enterprise Fax (095) 465-86-86

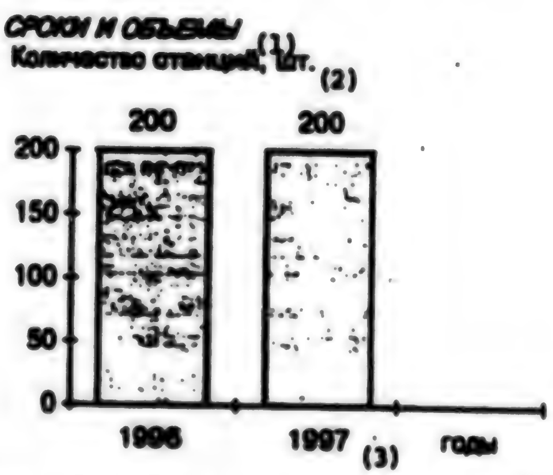
Svetlana Joint-Stock Company

Faza Scientific Design Technical Enterprise

Kontact State Scientific Production Enterprise

Central Scientific Reserch Institute of Automation

Project. Development Work and Standard Production of Mobile Radio Relay Stations for Reporter Operationally Deployable Communication Lines



Key: 1. Times and Volumes. 2. Number of Stations. 3. Years.

Provision is made for constructing small analog radio relay lines for the organization of reporting and an information air-cable network operating in the frequency range 14.4-15 GHz with an output power not less than 0.5 W.

The production of a small radio relay station intended for television transmission and audio accompaniment channels operating in the range 15 GHz will be organized within the framework of the project.

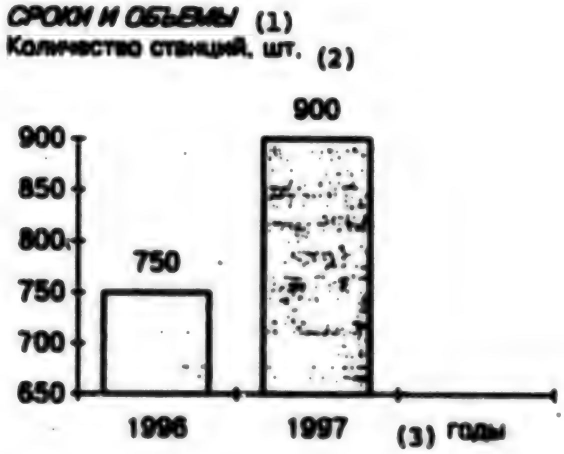
Funding and Cost Recovery Period

The approximate amount of investment is 1 million dollars. The anticipated cost recovery time is 1 year from the commencement of standard production.

Istok State Scientific Production Enterprise Fax (095) 465-86-86

Project. Development Work and Standard Production of Digital Radio Relay communication Stations Operating in Ranges 3.6-38 GHz.

Digital radio communication systems are becoming the principal means for information transmission. Digital radio relay stations (lines) have a high handling capacity and are characterized by simple erection and servicing. They are substantially less expensive than cable lines. The project is directed to the development of digital radio relay communication complexes intended for providing telephone services for rural regions, farming enterprises and connecting large automatic dial offices in large cities.



Key: 1. Times and Volumes 2. Number of Stations 3. Years

The production of small digital radio relay systems and RRL receiving- transmitting equipment will be organized within the framework of the project.

Funding and Cost Recovery

The necessary investment will be 6.0 million dollars.

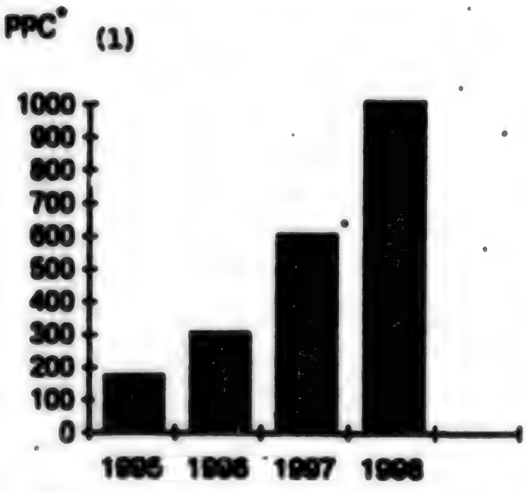
The anticipated cost recovery time is 1 year after commencement of standard production.

Istok State Science Production Enterprise Fax (095) 465-86-86 Salyut Science Production Enterprise Almaz State Science Production Enterprise Svetlana Joint-Stock Company

Project. Development Work and Standard Production of Modern Radio Relay and Surface Satellite Stations Operating in Frequency Ranges 1.5-90 GHz

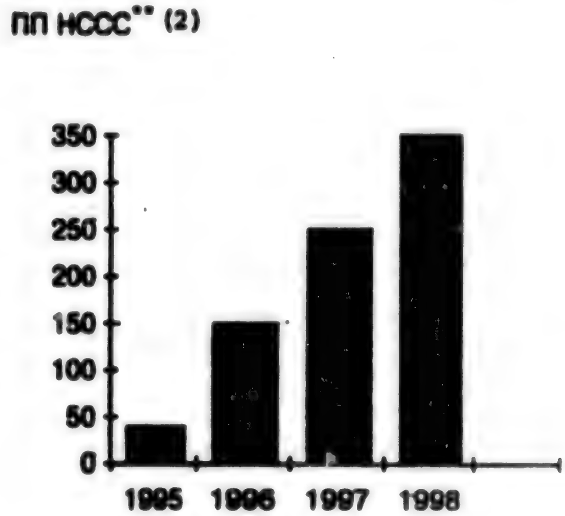
The creation of digital radio relay communication stations and receiving-transmitting equipment for satellite communication surface stations and radio relay stations for organizing television reports from the site of events and inexpensive radio relay stations protection systems will make it possible to ensure reliable modern communication facilities for more than 20,000 populated places in Russia separated a great distance from one another and from major centers.

Work To Be Done Within Scope of Project



1. Radio relay stations

- Acquisition of foreign prefabricated technological equipment for surface erection and equipment for welding microwire, measuring equipment (in particular— measurements of complex parameters of microwave and LF digital communication equipment channels);
- Organization of production of modem equipment for communication systems of channel-forming equipment with use of component base produced by American companies;
- Organization of production of radio relay communication complexes and receiving-transmitting equipment for base and satellite communication surface stations (ranges of radio relay communication lines 2, 6, 8, 11, 18, 18, 40, 90 GHz, satellite system ranges 4/6 and 11/14 GHz).



1. Surface satellite communication receiving-transmitting stations

Funding and Cost Recovery Period

The necessary investment is 16 million dollars

The anticipated funding results are presented in the diagrams.

The anticipated cost recovery time is 3 years, beginning in 1996.

There are numerous contacts with American microwave instrument companies.

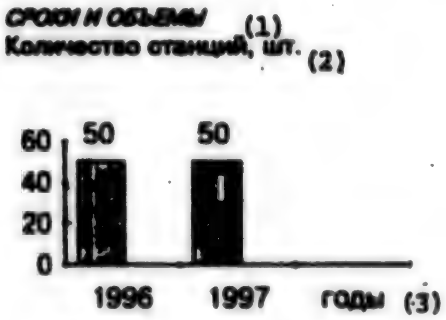
The implementation of this conversion project will make it possible to reorient the work of 600 specialists of the State Science Production Center and create new jobs for them.

Istok State Production Enterprise Fax (095) 465-86-86

Project. Development Work and Standard Production of Digital Data Transmission Stations in Frequency Range 92-95 GHz

The project provides for the creation of a system of directional duplex radio communication intended for the reception and transmission of digital information as a part of local computer networks and also information systems. The range of working frequencies is 92-95 GHz, the radiated microwave power is not greater than 50 mW and the range of stable all-weather communication is 3 km.

The production of a digital radio relay system operating in the 3-mm range will be organized within the framework of the project.



1. Times and Volumes 2. Number of Stations; 3. Years

Funding and Cost Recovery Period

The necessary investment is 1.4 million dollars.

The anticipated cost recovery period is 2 years from commencement of standard production.

Istok State Science Production Enterprise Fax (095) 465-86-86 Almaz State Science Production Enterprise Erikom State Science Production Enterprise Salyut Science Production Enterprise

Project. Development of Equipment for Reception of Signals of Satellite Television and Air-Cable Information Networks

The project provides for the development of a new generation of instruments and receiving-reception modules for complexes (surface and satellite) of satellite communication and ether-cable information networks.

Technical Specifications

Satellite receiver of TV signals with digital control:

frequency range 0.95-1.75 GHz,

input power 60-90 dB/W,

amplitude of output signal 1 W,

number of stored programs 99

the outfit includes: TVS channel selector, tuner, program shaper, converter;

Main station for new-generation cable systems:

range of input frequencies 48.5-700 MHz,

range of output frequencies 48.5-300 MHz,

number of transmitted channels 4, 8, 16;

Receiving-transmitting complex for relaying surface TV programs for small populated points:

input frequency 10.95-12.5 GHz,

output frequency 171.25-800 MHz,

output power of transmitters 1-10 W,

effective radius up to 5 km,

number of transmitted programs — 3-4,

number of subscribers — up to 100.

Times and Volumes

Satellite receiver of TV signals

— 3 experimental copies — 1996

— tuners — 10,000 units — 1996

— converters — 100,000 units — 1996

— program shapers — 100,000 units — 1996.

Receiving-transmitting complex for relaying surface TV — 100 units — 1996 Main station — 100 units — 1997.

Funding and Cost Recovery Period

The approximate amount of the necessary investments for implementing work under the project is 6.5 million dollars.

With performance of the specific volumes of production costs will be recovered in 1997.

Almaz State Science Production Enterprise Fax (845) 2-14-02-57 Istok State Science Production Enterprise Oktava State Enterprise Erikom State Science Production Enterprise

Project. Development Work and Practical Production of TV Journalist Direct Transmission Equipment

The project provides for development of radiotelevision communication equipment for a small mobile TV station (MTVS) and a TV center via a repeater and portable

radiotelevision equipment for direct transmission TV journalist outfit.

Technical Specifications

Working frequencies:

Small MTVS:

— transmission 15 GHz

— reception 13 GHz

Television center

— transmission 14 GHz

— reception 11 GHz

Communication channel for TV correspondent with MTVS

— 1.4-2 GHz

The time for deployment of the MTVS is not more than 1 hour.

The time for deployment of the TV journalist's equipment is not greater than 15 minutes.

The number of TV journalists serviced by one MTVS is 2.

The time of continuous operation of each TV journalist from one power source is up to 2 hours.

Work to be done within scope of Project Development work and practical production of radiotelevision communication equipment.

Times and Volumes

Mobile TV station — 10 outfits, 1998.

Central station — 10 outfits, 1998.

TV journalist outfits — 50 units, 1997.

Funding and Cost Recovery Period

The approximate amount of the necessary funding for implementing work under the project is 1.5 million dollars. The form of funding is an advantageous loan for 2 years.

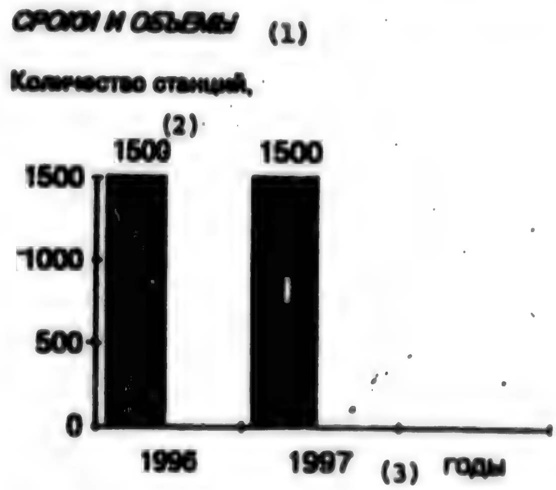
With performance of the stipulated volumes of production costs will be recovered in 1998. The time for full return of the low, including interest, is the second half of 1998.

Electronic Instruments Special Design Bureau, Svetlana Joint-Stock Company Fax (812) 553-70-01

Project. Development Work and Standard Production of Personal and Automobile Multichannel Radio Stations

The project provides for developing the production of personal and automobile multichannel radio stations operating in the range 26.975-27.4 MHz with 39 channels.

The production of multichannel simplex radio station outfits will be organized within the scope of the project.



1. Times and Volumes 2. Number of Stations 3. Years 4. Istok State Science Production Enterprise

Funding and Cost Recovery Period

The necessary investment is 1.5 million dollars.

The anticipated time for recovery of costs will be 1/2 year after commencement of standard production.

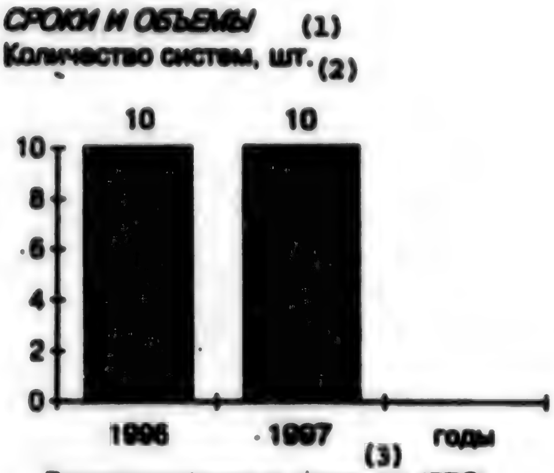
Istok State Scientific Production Enterprise Fax (095) 465-86-86

Project. Development Work and Standard Production of Cordless Telephone and Radio Telephone Systems

The project provides for the production of cordless communication systems (range 400-910; 1900 MHz) and a digital radio telephone system with multistation access for establishing primary radial-nodal networks suitable for organizing departmental urban networks, interim radio telephone communication networks in regions of new construction, closed special communication (networks range of working frequencies 1.7-1.9 Hz and 18 GHz, maximum number of subscribers 512, radius of serviced territory up to 500 km).

The production of a digital radio telephone system with multistation access and the production of cordless

telephone systems will be organized within the scope of the project.



Радиотелефонные системы (РТС)

Radio Telephone Systems (RTS).

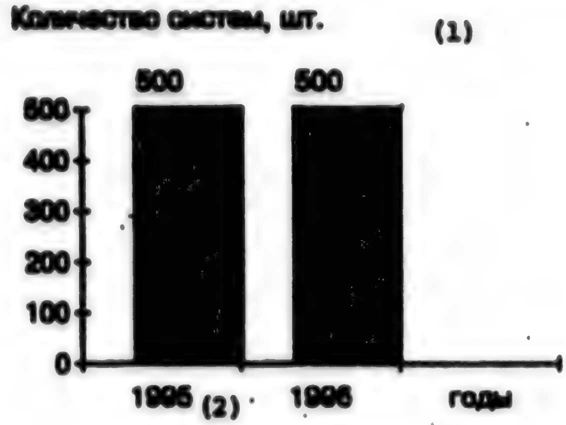
1. Times and Volumes 2. Number of Systems 3. Years

Funding and Cost Recovery Period

The required investment is 24 million dollars.

The anticipated cost recovery period is 2 years from the commencement of standard production.

Svetlana Electronic Instruments Joint-Stock Company Fax (812) 553-70-01. Almaz State Science Production Enterprise Central Scientific research Institute of Information and Automation Salyut Science Production Enterprise Oktava State Enterprise



Cordless Telephone Systems (CTS).

1. Number of Systems 2. Years

Project. Development of Production and Manufacture of Modern Models of Electronic Hearing Aids and Components for Them

Provision is made for the development and manufacture of hearing aids of the types carried in the pocket, worn outside and inside the ear and others with a wide range of technical and ergonomic characteristics.

Work To Be Done Within Scope of Project

- Organization of standard production of hearing aids of different types and models up to 200,000 units per year;
- Organization of standard production of microphones, telephones, miniaturized variable resistors and microswitches up to 25,000-300,000 units per year;
- Organization of a far-flung network for marketing and medical-technical servicing.

Times and Volumes

Name of product	Volume of production (thousands of units)		
	1994	1995	1996
U-06 hearing aid, outside ear	30	20	-
Small U-07 hearing aid, outside ear	10	40	50
Child's U-09 hearing aid, outside ear	10	20	50
Programmable pocket hearing aid with microwave coupling	-	10	50
Intraear hearing aid (of American ZM Company type)	-	10	50
M7 microphone (Knowles EM series)	60	110	250
EM1956 telephone (Knowles EP series)	60	110	250

The planned volume of increase in production and the assortment of different models of hearing aids and accessories for them in 1997 and the years which follow will be determined from the results of sales in 1996. As a result of making these investments there will be assurance of creation of jobs for specialists of the Istok State Scientific Production Enterprise.

Funding and Cost Recovery Period

In order to handle the formulated tasks the necessary amount of investments is 20 million dollars.

They are distributed in the following way:

Production of microtelephones — 3 million dollars

microphones — 3 million dollars

variable resistors — 2 million dollars

microswitches — 2 million dollars

Equipment for assembly and control of hearing aid parameters — 3 million dollars

Equipment for precise molding of plastics (with volume of production 20 cm^3 — 1 million dollars

Organization of far-flung network for performing medical-technical servicing — 1 million dollars

Performance of scientific research and design work, preparations for production, fabrication of fittings, acquisition of materials, integration and assembly and other expenditures — 5 million dollars.

Beginning in 1996 the volume of sales, taking into account an average cost of a unit 100,000 rubles, is 20 billion rubles annually, the equivalent of 16 million dollars. It is proposed that 30 percent of the units be sold in the countries of eastern Europe, Asia and the CIS countries. The annual profit from the sale of hearing aids will be 5 billion rubles annually (4 million dollars). Thus, the anticipated time for recovery of costs will be 5 years, beginning with 1996.

In accordance with legislation in force in the Russian Federation the production of hearing aids is not assessed a tax on profits or a value-added tax.

The Istok State Scientific Production Enterprise had contacts with the British-American Knowles Company with respect to the production of telephones and microphones, and with respect to the production of hearing aids with the Oticon Company (Denmark). The Istok State Scientific Production Enterprise has had no business connections with American producers of hearing aids.

Istok State Scientific Production Enterprise Fax: (095) 465-86-86

Project. Development of Equipment and Low-Waste Energy-Conserving Technologies for Processing Wood and Other Construction Materials

The project provides for the development of fundamentally new technological equipment equipment and processes with use of sources of microwave energy for drying, heating and modification of wood and other construction materials. Microwave radiation has the following advantages:

high absorptivity of microwave radiation by moist wood proportional to the percentage of moisture content;

possibility for imparting high energy in a unit volume and its removal; selective heating and self-regulated temperature distribution as a function of moisture content;

total lack of inertia in control of intensity of heating and a high accuracy of its regulation;

virtually 100 percent efficiency of conversion of microwave energy into thermal, low losses in conducting channels and working chambers;

replacement of "wet" heating methods (water, steam) by "dry" methods (a field).

Technical Specifications

The different types of equipment are intended for use in sawmill, lumbering and wood processing enterprises, furniture, veneer and match factories and in the production of paper items and ensure:

Radical (by a factor of 10 or more) acceleration of processes for nondamaging thermal processing, drying, gluing and modification of forest materials.

Processing of hardwood into small sawn wood products (parquet, dowels, packing materials, etc.) making use of more than 12 million cubic meters of wood without additional capital investments in lumbering.

An increase in raw material resources to 16 million cubic meters (in addition to the mentioned 12 million cubic meters) due to a reduction in losses of sawn timber by 2.9 million cubic meters, DSP by 0.4 million cubic meters, glued veneer and shaved dowels by 0.36 million cubic meters.

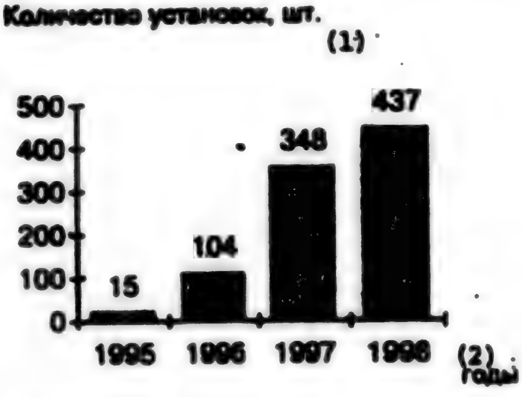
The expenditures of all types of energy is reduced by a factor of 1.5-2.

The equipment is based on standardized sources of microwave energy in the ranges 915-2,450 MHz with powers from 10 to 200 kW.

Times and Volumes

In the course of implementation of the project 15 types of equipment will be developed for different purposes during the period 1994-1997 with the organization of production in 1996-1998.

The total volumes of production for 14 types of equipment are represented in the bar graph.



1. Number of Units 2. Years

Funding and Cost Recovery Period

The cost of development of equipment and processing procedures with the organization of production is 8.5 million dollars. The cost recovery period for each type of equipment is 1.5 years from the commencement of experimental production (more than 10 units per year).

Istok State Scientific Production Enterprise Toriy State Scientific Production Enterprise Lesprom All-Russian Scientific Production Association Kontak Special Design Bureau Svetlana Joint-Stock Company

Project. Further Development and Organization of Large-Scale Production of Microwave Ovens for Household and Industrial Purposes

The project provides for further development of the design of household and industrial (low-power) microwave ovens competitive with respect to technical specifications to those on the world market, as well the development of technology and equipment for large-scale production with a considerable decrease in work expenditures.

In the project special attention is given to the biomedical aspects of the use of microwave energy in daily life and high-quality food preparation.

The advantages of microwave ovens are widely known and do not require additional clarifications.

Household ovens are now produced by more than 10 factories in Russia, but their number is inadequate and the quality is considerably inferior to the best imported copies. However, the demand of the domestic market is 2-3 million units annually.

Work to Be Dome Within Scope of Project

- Reduction in use of materials by 25-35 percent with reduction of oven weight to 16-20 kg.
- Introduction of modern automatic control systems.
- Further development work on possibility of using inventory sources of power of resonance type.
- Increase in volume utilization factor by 15-20 percent and efficiency to 55 percent.
- Improvement in design to design level of leading foreign companies.
- Development of oven with increased power (up to 2 kW), as well as designs of ovens based on solid-state sources of microwave energy.

Technical Specifications

It is proposed that 8 types of ovens be developed for household and industrial purposes with the following principal characteristics:

— power in chamber 550-2,000 W;

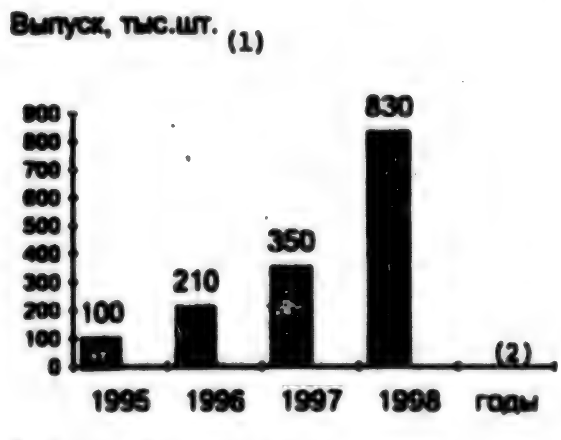
— chamber volume 14-55 dm^3;

— weight 15-40 kg;

— high efficiency, automated control of processes.

Times and Volumes

The period for development work is 1994-1996, for the organization of production it is 1995-1998. The standard production volumes of the 8 newly developed types of ovens are indicated in the figure.



1. Production, thousands of units

Funding and Cost Recovery Period

The cost of development work and the organization of standard production is 4.5 million dollars. The cost recovery period for the project is 1.5 years after commencement of standard production.

Pluton Joint-Stock Company Fax: (095) 917-19-20

Toriy State Scientific Production Enterprise

Istok State Scientific Production Enterprise

Faza Scientific Design Technical Enterprise

Tantal Special Design Bureau

Kontakt Special Design Bureau

Project. Research on Influence of Electromagnetic Waves in Millimeter Range on Biological Objects and Development of Biomedical Equipment

Research on the effects of interaction between electromagnetic waves in the millimeter range and biological objects and study of the possibility of use of these waves in different fields of biology and medicine, carried out since the mid-1960's by many organizations in Russia and the CIS, in the early 1980's developed work on use of the methods of millimeter therapy (EHF therapy) and diagnosis. The developed EHF therapy equipment of the Yav series underwent medical testing and is being used in Russia and in the neighboring countries for treating a broad range of diseases, including traumatology, gastroenterology, oncology, skin, cardiovascular and other diseases.

Work to Be Done Within Scope of Project

- Equipment and methodological support of investigations of biologic effects of electromagnetic waves in millimeter range as a fundamental scientific problem;
- Development of methods for EHF therapy and diagnosis, improvement in medical equipment operating in the millimeter range and equipment for intensifying biological processes;
- Development of instruments for investigating molecular structure of matter.

Funding and Cost Recovery Period

The necessary investment is 5 million dollars. It is assumed that the cost recovery period will be 3-4 years.

Specialists from Western and Eastern Europe, United States, Canada and South America are exhibiting great interest in matters of the biological impact of millimeter waves, methods for EHF therapy, and especially the work done by the Istok State Scientific Production Enterprise (GNPP).

In 1993 a contract was concluded between the istok GNPP and Temple University in Philadelphia. In accordance with the contract the Istok GNPP is supplying equipment for irradiating biomedical objects in the range from 37.5 to 118 GHz and an EHF for studying aqueous solutions. The preparation of a contractual scientific research program is proposed.

Istok State Scientific Production Enterprise Fax (095) 465-86-86

Project. Radar System for Navigational Support of Ship Berthing

The radar system for navigational support of the berthing of ships (SOSh) is intended for ensuring the maneuvering of ships during berthing (docking, locking) under conditions of limited visibility and for determining the position of a ship relative to a pier. The system makes possible simultaneous measurements of the ship's range and speed or its individual parts and the wharf. The system is designed in two variants: pier(SOSh-P) and shipboard (SOSh-B).

Technical Specifications

Effective Range, not less than, m ... 100

Accuracy in measuring range, m ... 0.5

Range of measured speeds, not less than , m/s ... 3

Accuracy in measuring speed, m/s ... 0.1

Range of radiated frequencies, GHz ... 36-37.5

Funding and Cost Recovery Period

Proposed sequence for conducting work and necessary investment:

Development of experimental copy of SOSh-B berthing system.

— Investment 0.3 million dollars.

— Time required for performing work — 9 months.

— Manufacturer: Istok State Scientific Production Enterprise (GNPP).

Conducting laboratory and setting up field tests.

— Investment: 0.2 million dollars.

— Time required for performing work 1.5 years.

— Manufacturer Istok GNPP.

Installation of the system aboard a ship and conducting field tests.

— Investment: 2 million dollars.

— Time required for performing work 2.5 years.

— Manufacturer: Istok GNPP and a foreign company.

Development of an experimental copy and design documentation for a shipboard variant of a berthing system.

— Investment: 0.5 million dollars.

— Time required for performing work 3.5 years.

— Manufacturer: Istok GNPP.

Organization of standard production of SOSh-B.

— Investment: 1 million dollars.

— Time required for performing work 4 years.

— Manufacturer: Istok GNPP and a foreign company.

It is assumed that the cost recovery period will be 2 years from the commencement of standard production.

For work on this project, other than funding, it is necessary to have partners having experience in developing and introducing shipboard equipment and experimental base.

Istok State Scientific Production Enterprise Fax (095) 465-86-86

Project. System for Controlled Slowing of Railroad Cars When Breaking Up Trains on Classification Hump and System for Control of Electric Propulsion Motors of Locomotives on Basis if Radar Speed Sensors Operating in Millimeter Range

The project provides for development of a system for controlled slowing intended for one track operating unit (8 classification tracks), which will make it possible to control the level of filling of the classification tracks in a zone up to 450 m.

The system must include 8 speed sensors of the RIS type and a device for linking the sensors with a computer of the IBM PC AT type. The software based on the speed of uncoupling measured by the sensor and two sensors of rail circuits in the slowing position must determine the distance to uncoupling, acceleration of uncoupling, predict the point of stoppage of decoupling and on the basis of these data control the slowing of decouplings in the slowing position.

In order to increase the accuracy and reliability of measurement of the rate of uncoupling, and on its basis, also other parameters, modern digital processing of signals must be introduced into the sensor.

Development of a sensor of true speed of the locomotive will make it possible develop a device for the automatic control of thrust electric propulsion of locomotives for anticoupling and antislipping systems.

Work Provided for Under Project

Joint mastery of production of systems for controlled slowing of cars and control of electric motors o locomotives with introduction of digital processing of signals.

Development and fabrication of system for digital processing of signals for both hump and locomotive sensors:

Investment: 0.4 million dollars. Manufacturer: Istok State Scientific Production Enterprise (GNPP). Time required for completion of work: 1 year.

Finalization of software for introduction of modern system for digital processing of signals.

Investment: 0.5 million dollars. Manufacturer: Istok GNPP. Time required for completion of work: 1 year.

Fabrication of experimental copies of control system on basis of hump and locomotive sensors and testing.

Investment: 3 million dollars. Manufacturer: Istok GNPP and American company. Time required for completion of work: 2 years.

Organization of standard production of systems.

Investment: 0.5 million dollars. Manufacturer: Istok GNPP, American company. Time required for completion of work: 3 years.

The realization of this project is possible with close cooperation with American companies engaged in developing systems for digital processing of signals.

Istok State Scientific Production Enterprise Fax (095) 465-86-86

Project. Development of Radar Sensors in Millimeter Range for Preventing Automobile Collisions

The project provides for development of radar sensors capable of picking up moving and fixed objects constituting a danger to an automobile at any time of day and under any weather conditions. Three principal parts of such radar sensors can be defined:

— electronic part, consisting of a signal shaping system, receiver-sender, antenna;

— system for digital processing of signals;

— information display system.

Within the scope of the project there will be joint development and startup of production of radar sensors

fabricated using American LSI chips or for the digital processing of signals and the display of information.

Funding and Cost Recovery Period

Proposed sequence for conducting work and necessary investment:

Development and fabrication of experimental copy of electronic part of radar sensor in millimeter wavelength range.

Investment: 0.5 million dollars. Manufacturer: Istok State Scientific Production Enterprise. Time required for completion of work: 2 years.

Writing of algorithms, development of technical equipment and software for signal processing.

Investment: 1.5 million dollars. Manufacturer: Istok State Scientific Production Enterprise and American company Time required for completion of work: 2 years.

Development of experimental copy of radar sensor and its testing.

Investment: 3 million dollars. Manufacturer: Istok State Scientific Production Enterprise and American company Time required for completion of work: 4 years.

Organization of standard production of radar sensor:

Investment: 5 million dollars. Manufacturer: Istok State Scientific Production Enterprise Period for completion of work: 5 years. Cost recovery time: 3 years from beginning of standard production. The realization of the project is possible with close cooperation with American companies engaged in the development of promising transportation facilities and developing systems for the digital processing of signals.

Istok State Scientific Production Enterprise, Fax (095) 465-86-86

Project. Development of Equipment and Technologic Production Processes for Food and Processing Branches of Agroindustrial Complex

The project provides for the development of fundamentally new technologies for the processing of agricultural products on the basis of use of microwave energy ensuring reserve and energy conservation, ecologic cleanness, maximum automation and a modern level of production. The advantages of microwave technologies are; interaction between biologic systems, with the energy source (electromagnetic microwave field) at microprocessor levels; high rate of heating and total inertia in the change in field gradients; possibility of resonance impact on the structures of biological objects; preclusion of losses of mass and reduction in the food value of products; considerable reduction in work force and production areas.

Technical Specifications

It is proposed that 15 types of equipment and accordingly technological processes:

— drying of vegetables and fruits (container and conveyer types), trade name preparations, silkworm cocoons (4 types);

— disinfection and presowing processing of grain crops (2 types);

— defrosting of meat and sterilization of sausage meat (3 types);

— pasteurization of milk products (2 types);

— processing of soya beans, cacao and soya products (2 types);

— pulverization of fodders (1 type);

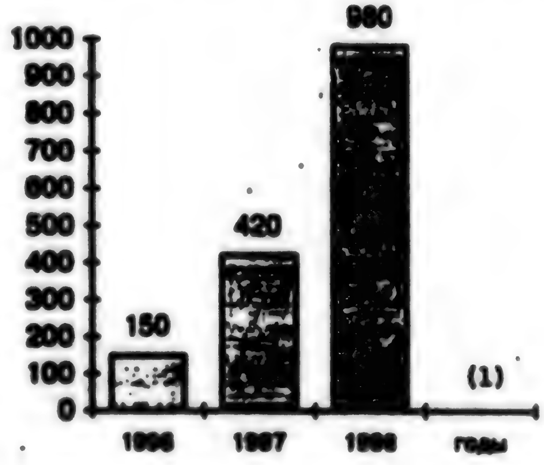
— processing of viticultural products (1 type).

The equipment is based on standardized energy sources with powers 5, 10, 25, 50 and 100 kW in the ranges 915 nd 2450 MHz with automatic control.

The productivity of the equipment and technological processes averages 3 tons/hour, with respect to the presowing processing of grain crops is up to 20 tons/hour and for milk products is up to 2 m³/hour.

Times and Volumes

The period of development work is 1994-1996; for the organization of production it is 1995-1997. The volume of production is 15 types of equipment during the period 1996-1998.



1. Years

Funding and Cost Recovery Period

The cost of developing equipment and technologies for the project is 5 million dollars. The time for full recovery of the costs of the project is the beginning of 1998.

Toriy State Science Production Enterprise Fax: (095) 332-54-66. MAGAPB. Polermo NKPF. Faza NKTP. Kontakt Special Design Bureau.

Project. Development of Microwave Equipment and Technologies for Many-Sided Processing of Hydrobionts and Production of Food and Fodder Fish Products

The project provides for the development of technologies and organization of standard production of ecologically safe equipment intended for the many-sided development of the fish-processing branch and increase in food production.

A special feature of the project is the development of fundamentally new technologies for the processing of hydrobionts on the basis of use of the energy of a microwave electromagnetic field in level exceeding traditional Russian and foreign technologies. The high efficiency in using microwave energy when processing hydrobionts is attributable to its almost 100 percent absorption by water molecules with transformation into thermal energy in the entire volume of the raw material, something which cannot be done when using any other traditional heating methods.

The microwave technology for processing hydrobionts in comparison with the technologies currently used in the branch ensures:

— high rate of inertialess heating;

— shortening of the duration of technological processes by a factor of 3-100;

— considerable improvement in quality and increase in output of the finished product by 8-30 percent;

— bactericidal effect with an increase in shelf life of the products;

— ecologic cleanness of the processes;

— total exclusion of use of steam, compressed air, water and expenditures on its purification for technological purposes;

— reduction of power expenditures by 50 percent;

— possibility for total mechanization and automation of processes, etc.

Progressive microwave technologies are highly efficient in the processes thawing, thermal processing, drying and extraction, blanching, pasteurization and sterilization of fish and sea products.

Technical Specifications

It is proposed that 9 types of equipment, and accordingly, technological processes, be developed:

— chamber and conveyor belt thawing of fish and sea products (2 types);

— hot smoking and heat processing of fish (2 types);

— pasteurization of fish eggs (1 type);

— drying of fish meal (1 type);

— thermal processing of mollusks (1 type);

— harvesting fat from sea animal (1 type);

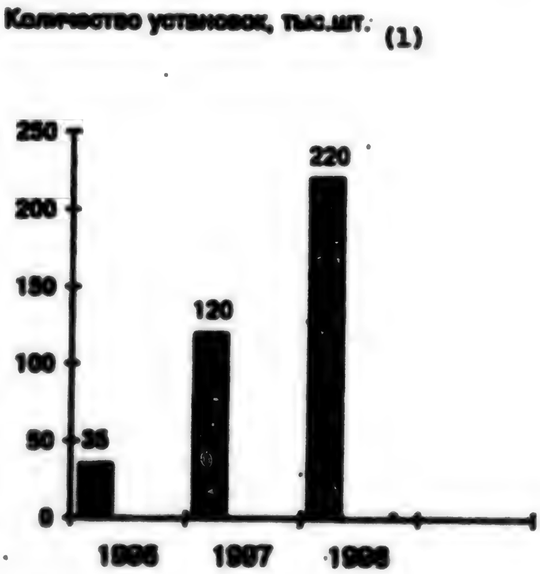
— extraction of biologically active substances (1 type).

The equipment is based on standardized power sources 5-50 kW in the range 915-2450 MHz (see project for agroindustrial complex).

The productivity of the equipment averages 2.5 tons/hour.

Times and Volumes

Period of development work — 1994-1996, organization of production — 1995-1997. Total volumes of production during period 1996-1998 shown in figure.



1. Number of Units, Thousands

Funding and Cost Recovery Period

The cost for developing the equipment and project technologies with the organization of production is 3.5 million dollars. The cost recovery period is 2 years from commencement of production.

Toriy State Scientific Production Enterprise Fax (095) 332-54-66 All-Russian Institute of the Fishing Industry and Oceanography Istok State Scientific Production Enterprise

Semiconductor Electronics — Generator of Technical and Economic Progress

Yu. P. Dokuchayev, Doctor of Technical Sciences

Developing semiconductor electronics is constantly changing the appearance of electronics equipment and semiconductor instruments have always served as a basis for fundamentally new types of electronic devices in different fields of instrument making. This makes it possible to assert that such an important sphere of human activity as the reception and transmission of all types of information already by the year 2000 will be fully determined by the capabilities of microelectronics, as well as high-frequency (HF) and microwave semiconductor electronics.

The basis for HF and microwave semiconductor electronics is different kinds of silicon and gallium arsenide transistors, diodes, varactors, linear monolithic and hybrid microwave circuits.

However, this is only one of the principal component parts of the general problem of a modern communication system. For promising communication systems digital methods for transmitting information in a broad frequency band with a complex structure of signals are beginning to come into wider and wider use for ensuring a great carrying capacity, noise immunity and low power of radio transmitting devices. This is ensured by information coding and multiplexing systems and systems for information decoding on the basis of high-speed digital large (LSI) and very large (VLSI) chips for special signal processors.

Cellular Communication System

In order to improve large-scale communication systems based on rapidly developing radio telephony, including cellular systems for cities and populated places, small size, small radiated microwave power (for ensuring ecologic safety) and a low cost of equipment in production are factors of fundamental importance.

In this form of radio telephonic equipment, which with respect to its compactness can be assigned to the class of "pocket equipment," there is a concentration of the most complex requirements on the new elemental base of semiconductor electronics from the point of view of a high degree of integration and speed.

However, the indicated features are not contradictory and can be ensured on the basis of purposeful development work:

- high-speed digital silicon CMOS VLSI chips for special processors with audio frequencies more than 50 mHz for coding and processing verbal information;
- linear monolithic and hybrid gallium arsenide microwave circuits for the decimeter range for the reception and transmission of information in the form of digital signals with a complex structure for ensuring the necessary noise immunity and a high potential in the radio line;
- high-speed gallium arsenide digital-to-analog and analog-to-digital converters;
- all passive components (resonators, capacitors, piezoelectric items, etc.) in the form of "chips" for surface mounting for the purpose of ensuring a high mounting density of the piece of equipment as a whole.

The indicated work complex forms part of the new elemental base of the Russian State Program for the Development of Electronics Technology.

The distinguishing feature of the new items is the possibility of their use in cellular radio telephony.

Large-scale produced radio telephony equipment in the promising range will be competitive on the world market. However, the greatest economic interest in this problem will be concentrated within the country.

Expert evaluations show that over the course of the next 10 years the internal market for cellular telephons may be 1-5 trillion rubles.

About 25-30 billion rubles is required in the next 3-5 years for creating the new elemental base. This indicates the exceptionally high economic effectiveness and the rapid cost recovery for scientific development work.

The second component part is the long-distance communication system.

Space Communication Systems

Communication systems with a great carrying capacity operating via satellite repeaters in most cases situated in geostationary orbits are now operating in our country and throughout the world.

In combination with urban cellular communication systems space systems can provide a unified national com-

munication system with a linkup to the international system.

The radio transmitting channels of space communication systems must have an adequately high power (from a few to several tens of watts, depending on the purpose and carrying capacity of the station) for ensuring information to a repeater satellite for a distance of 36,000 km.

The Russian State Program for the Development of Electronic Technology (hereafter called the "Program") provides for the creation of all the elemental base necessary for this.

This applies, in particular, to the creation of powerful and low-noise gallium arsenide transistors and integrated circuits, as well as assemblies and units of communication equipment based on them for the exploited and promising frequency ranges.

Under the program plans call for the development of low-noise transistors for the frequency range from 4 to 220 GHz with a noise factor 0.25 to 10 dB respectively.

In the field of powerful gallium arsenide transistors plans call for developing instruments operating at working frequencies from 6 to 220 GHz with a released power from 25-30 W to 0.05 W corresponding to the working frequencies.

Special types of powerful wide-band gallium arsenide transistors for the frequency ranges 3.4-3.9, 4.3-4.8, 5.6-6.3, 7.1-7.8, 7.9-8,4 and 10.7-11.7 GHz will be developed for specific types of radio transmitting equipment.

Such a microwave elemental base, in combination with high-speed signal processors, will make it possible to create channel-forming equipment for the digital processing of transmitted and received information in sizes not exceeding 3-5 liters (that is, in "case" dimensions), but a radio channel in a size not greater than 1 liter. A piece of equipment of such a small size makes it possible to speak realistically of the approach of the time of creation of both "personal" space communication stations for the population and different kinds of departmental communications (banks, transportation, fuel-energy complex).

In order to evaluate economic effectiveness, as an example it can be shown that just the indicated departmental communication systems will create a market for surface equipment alone in an amount of about 1.5 trillion rubles. Expenditures on creation of the elemental base under the Program must be about 10 billion rubles. As in the case of cellular telephony the economic effectiveness of creating space communication systems is extremely high and the entire problem merits the speediest possible resolution.

Short Radio Relay Communication Lines

Short wide-band radio communication relay lines connecting the central communication nodes with the surrounding periphery in the countryside may become the third link in mass communication. With respect to the technical capabilities already attained, the most feasible undertaking is the creation of such lines in the millimeter wavelength range for providing broad frequency band, ensuring a small size of antennas and low production costs.

The Program provides for different types of small sources of microwave power in the form of silicon and gallium arsenide avalanche transit time diodes, Gunn diodes and gallium arsenide microwave transistors with limiting frequencies of about 220-300 GHz, as well as multiplying, switching and mixing diodes with a low level of low-frequency noise and low-barrier mixing diodes, the total range of which quite fully takes in virtually all aspects of millimeter and submillimeter instrument making for promising communication systems.

Electronic Equipment for Radar, Navigation and Telemetry Based on Powerful Microwave Bipolar Silicon Transistors

A major section in the Program is devoted to the further development of series of powerful microwave bipolar silicon transistors for different applications in modes for radiation of continuous power and in pulsed modes with pulse durations from a few to hundreds of microseconds.

Since sounding pulses with a complex structure are coming into use in modern information systems, among which radar can be included, a distinguishing feature of the new development work is a relatively large band of working frequencies, as well as a large conveyed specific and absolute power.

Transistors operating in the decimeter frequency range will have a working band of about 200-300 mHz with a conveyed pulse power from 100 to 500 W, depending on the working frequency.

The indicated series of powerful microwave silicon transistors, in combination with the developed powerful microwave gallium arsenide instruments, must ensure solution of the problems involved in creating different types of electronic equipment, telemetry, special communication and navigation in the decimeter and centimeter wavelength ranges.

In particular, the indicated instruments make it possible to create radar systems with electronic scanning on the

basis of active phased antenna arrays for different fields of application for great and short ranges of observation and detection of targets.

Powerful MDS Field and Bipolar Transistors and Their Integrated Combinations — Basis for the Modern Stage in the Scientific-Technical Revolution in the Field of Power Electronics

In connection with the creation and rapid development of a new class of powerful semiconductor instruments conditions are being created for a new stage in technical and economic progress. Its basis, in the opinion of specialists, is the broad introduction of electronics into power electrotechnical equipment and light sources.

The principal types of electrotechnical power equipment is alternating current electric motors and electrical transformers. Their specific power (that is, power per unit mass) is the greater the higher the frequency of the alternating current. For example, a transformer with an output power of 4 kVA weighs about 50 kg when operating at a frequency 50 Hz and 3-4 kg when working at a frequency of 20 kHz. A similar ratio also applies for electric motors.

Fluorescent instruments using a high frequency of the alternating current have an efficiency which is 10-15 times higher than for instruments operating at a frequency 50 Hz.

The use of high-quality power is capable of ensuring an enormous saving of electric power, copper, electrotechnical steel and corresponding material, energy and work resources on their production. The saving may exceed the boldest predictions.

For realization of this possibility it is necessary to employ frequency conversion directly in the user's equipment.

The development of this new class of semiconductor instruments, in addition to the saving of energy resources, may make it possible:

— on the basis of use of power electronics to fundamentally reduce the input of material and labor in producing items in the electrotechnical industry and make them exportable;

— change the appearance of electrotechnical items and be a stimulator for revitalization in related branches, including in the metallurgy of electrotechnical and magnetic materials, fabrication of machine tools, etc.

The economic effect will be attained most rapidly in the production of mass series of electric motors, where the use of power electronics has begun.

Even now at a number of plants (Cheboksary Industrial Tractors Plant, Saratov Electromechanical Plant, etc.) the large-scale production of special highly efficient electric motors operating only with power electronics and intended for agricultural machines and electrical devices for household equipment (refrigerators, ironers) has been prepared and organized.

Taking into account what has been said above, the Program includes development work and industrial production of the corresponding power electronics elements and devices on the basis of MDS field and bipolar transistors.

This section of the Program includes:

MDS transistors with an N and P channel for voltages from 50 to 1,800 V with a switchable power from 0.4 to 35 kVa for devices with the highest-frequency conversion or a minimum commutation time;

bipolar transistors with an insulated gate for a voltage from 600 to 1,600 V and switched powers from 20 to 35 kVA for devices with a less high switching rate, but better economic indices;

functionally-finalized power modules based on MDS transistors for a voltage 500-1,000 V and a switchable power up to 150 kVA with a high switching rate;

functionally-finalized modules based on bipolar transistors with an insulated gate for a voltage of 1,000 V and a switchable power up to 200 kVa with greater switching times than in the MDS, but with better economic indices.

Most of this program is to be implemented during the period 1994-1997 and only the most complex points prior to 1997.

With appropriate investments, beginning with 1996-1997 it is possible to expect a real return in the form of an increase in the volumes of production in the electronics and electrotechnical industries, including due to exportation of power electronics elements themselves, for which orders are already being received today, including from foreign customers.

Special Television and Instruments With CCD

One of the principal fields of TV technology applicable to the Russian economy is special television, which is used in technical vision systems, scientific research, space communication, military operations and in security and medical systems, etc.

Photodetectors (PD) based on CCD photosensitive instruments are the most important of any of the mentioned special TV information systems.

The task of the electronics industry is the development of the necessary standardized base for meeting existing needs.

Despite the apparent diversity of different systems, the program provides for the development of a series of specialized linear and matrix CCD instruments and electronic systems for their control which must be satisfied quite completely by the developers of equipment for different applications. High-speed linear CCD instruments with a number of elements 2 x 2,048 and 2 x 5,048 and with readout frequencies up to 50 mHz will ensure solution of ecologic problems in a spectral survey of the Earth from space, pipe rolling and steel casting industry and medicine. Specialized high-speed matrix CCD instruments with a number of elements 576 x 500, 576 x 700 and 576 x 1,200 in combination with circuits for the control of CCD instruments and high-speed bipolar level converters will make it possible to create miniaturized specialized PD for solving problems in internal security, customs control, medicine and transportation and for the Ministry of Exceptional Situations. It must be noted that the creation of a Russian elemental base for special television purposes is desirable because it is virtually absent on the world market.

The realization of the mentioned prospects for semiconductor electronics is impossible without development of precision technology, special machine building and the production of ultrapure materials.

Project. Development and Production of Low-Noise and Powerful Gallium Arsenide Microwave and EHF Transistors for Highly Informative Communication Systems

A broad range of low-noise and powerful gallium arsenide transistors and integrated circuits at the present time is the basis for the development of highly informative communication systems.

The development and production of these items will make possible full supplying of microwave and HF equipment for the cellular telephony system, the system for fixed and mobile satellite communication via geostationary satellites and the network of radio relay stations.

All these communication systems in a short time are capable of providing telephone, telex and fax communication for remote cities and populated points and any point in the world.

Technical Specifications

The program provides for standard production in 1996 of items with the following parameters:

Low-power FET and HEMT transistors operating in the frequency range from 4 to 60 GHz with a noise factor from 0.3 dB to 2 dB respectively and an amplification factor from 12 to 4 dB respectively.

Power transistors operating in the frequency range 3.7-4.2 GHz with an output power 10-20 W, frequency range 5.6-6.2 GHz with an output power 10-20 W, frequency range 14-14.5 GHz with an output power 1-2 W, frequency rage 17-18 GHz with an output power 1.0-1.5W, frequency range 37-40 GHz with an output power 120-150 mW, frequency range 45-60 GHz with an output power 10-20 mW;

Power amplifiers operating in the frequency range 5.9-6.3 GHz, 14-15 GHz, 35-37 GHz with an output power from 40 to 0.3 W respectively;

Communication receiving converters operating in the frequency ranges 3.7-4.2 GHz, 10.9-11.7 GHz, 17-18 GHz, 35-37 GHz with a noise factor from 0.8 to 1.3 dB respectively and with a transmission factor 40-55 dB in different ranges;

Frequency converters 1.5/14 GHz, 1.5/30 GHz, 1.5/37 GHz.

Work To Be Done Within Scope of Project

- Development of a new generation of low-noise and powerful transistors, monolithic and hybrid integrated circuits, as well as assemblies and units based on their use.
- Development of high-technology equipment and a technology for molecular- beam epitaxy, ion alloying, electron lithography and low-temperature high-vacuum precipitation of metallic and dielectric films.
- Conducting basic work on the development of the theoretical principles for the designing and study of new instruments: heterobipolar transistors, tunnel-resonance diodes and other instruments based on quantum-dimensional effects.

Funding

The proposed amount of expenditures under the program for 1994-1997 is about 10 billion rubles, including expenditures for developing transistors and complex assemblies of 4.5 billion rubles.

Cost Recovery Period

The implementation of the program will fully provide the elemental base and microwave devices for such projects as the satellite communication systems Ekspress, Zerkalo, Gals and Bankir. The establishment of the surface receiving-transmitting equipment alone is

about 1.5 trillion rubles. The estimated cost of establishing local radio relay communication networks during the period 1997-2000 is 2-3 trillion rubles.

Pulsar State Scientific Research Institute Telephone 369-04-81 Fax 366-55-83 Teletype Moscow "GIBRID"

Project. Development and Production of Powerful Silicon Field Transistors Operating in Microwave Range for Radar, Navigation, Telemetry, Medicine and Communication

The project provides for the development and production of the following items:

- Powerful microwave bipolar and MDS transistors, including superlinear transistors for use in TV transmitters, repeaters, base stations for cellular communication and multichannel radio communication stations.
- Powerful microwave bipolar autogenerating transistors for use in medicine, so-called O radars for microwave therapy, as well as power sources in systems for the combustion of solid particles in filters for the exhaust of diesel engines.
- Powerful low-voltage microwave and MDS transistors in housed and unhoused designs for mobile communication equipment.
- Microwave pulsed bipolar transistors for navigation and equipment for control of air traffic in civil aviation and transportation systems.
- Powerful microwave MDS transistors for high-power output stages of TV repeater and local stations.

Technical Specifications

The level of superlinear power of bipolar transistors in the range 470-860 mHz is 50 W and linear in the range 860-960 mHz is 150 W.

The level of continuous power of bipolar transistors at a frequency of 915 mHz is 150 W.

The level of continuous power of MDS transistors at a frequency 1,000 mHz is 100 W.

The band of working frequencies for pulsed transistors has been broadened to 200-300 mHz; the shaping of sounding pulses of a complex structure is possible.

The pulse power in bipolar microwave transistors has been increased to 0.5-1 kW.

The power voltage for individual classes of bipolar and MDS transistors has been reduced to 6-12 V.

The planned work corresponds to and in some cases surpasses the foreign technical level. The planned price of the items is lower than the price for similar foreign items by a factor of 2-3.

Work To Be Done Within Scope of Project

Development and startup of production of a new generation of bipolar and MDS transistors with an increased level of power indices and increased reliability indices.

Development and startup of production of new promising types of transistors in small and plastic housings.

Organization of production with reduced labor input in technologic processes and high ecologic safety.

Times and Volumes

Most of the work is planned for 1995-1998.

The volumes of production are determined by the needs of the economy and capacity of the domestic and foreign markets.

Taking into account the rapid development of systems for cable television, mobile personal communication, modernization of national TV transmitting systems, development of electronic systems for civil aviation and transportation, the total approximate demand for the considered class of instruments is tens of millions of units with a total value of about 100 million dollars annually.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program is 10 million dollars. The indicated sum is evidence of an exceptionally high economic efficiency of the project due to the rapid cost recovery.

Pulsar State Scientific Research Institute, Elektronika Scientific Production Association Telephone 369-04-81 Fax 366-55-83 Teletype Moscow "GIBRID"

Project. Standard Production of Microwave Mixing Diodes Operating in 2-cm Range

Low-barrier highly sensitive mixing diodes are intended for operation in balanced and multibalanced mixers for small onboard radio receivers , in antenna receiving arrays and in surface radio equipment for satellite communication and TV systems.

The use of diodes of this type will substantially broaden the series of highly sensitive mixing diodes with a low heterodyne power, will make possible a considerable decrease in size and power consumption and an increase in the effective range of the instruments by a factor of 1.5-2.

Technical Specifications

Normalized noise factor 5.5 dB, f_{meas} = 15 GHz; Pr = 0.3 mW; L_{pch} 50.0 dB; f_{upper} = 50 GHz.

Work To Be Done Within Scope of Project

- Development of Standard Production.
- Development and fabrication of technologic fittings.
- Acquisition of technologic and test equipment.
- Preparation for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of diodes can be initiated in 1995 and increased by years (thousands of units): 1995 — 50,000, 1996 — 100,000, 1997 — 150,000, 1998 — 200,000.

Funding and Cost Recovery Period

The approximate amount of funding required for implementing the work program is 2.5 million dollars.

The form of funding is an advantageous loan for 3 years.

If the stipulated volume of production is met the investment will be fully recovered in 1997. The time of full repayment of the loan with interest is the first half of 1998.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Standard Production of Microwave Low-Noise Mixing Diodes

The microwave diodes are intended for use in geoinformation systems in the following types of equipment:

Radar, based on use of Doppler principle and principle of linear modulation of signal frequency.

Radio navigation.

Radio reception with passband including LF part of signal spectrum.

Radio transmitting (low-noise automatic frequency tuning) circuits, etc.

Systems for traffic (automobile, railroad, sea, air transport) traffic.

Safety systems for traffic on highways and railroads.

Systems for protection of objects.

Indicators of microwave radiation with increased sensitivity.

Use of diodes of this class will substantially broaden the series of mixing diodes with a low level of LF noise and will make it possible to increase the effective range and resolution of equipment; will make it possible to increase its reliability and practical feasibilityduring its production.

In addition, it will make possible a considerable decrease in power consumption and the size of the developed equipment with simultaneous attainment of the required energy characteristics.

Technical Specifications

Normalized noise factor — 10-12 dB (when f_{rec} = 10 kHz) Conversion losses 6-6.5 dB — (f_{meas} = 15 GHz) Output noise ratio — 2-6 relative units f_{rec} = 10 kHz)

Work To Be Done Within Scope of Project

- Development of standard production.
- Development and fabrication of technologic equipment.
- Acquisition of technologic abd test equipment.
- Preparation for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of diodes can be initiated in 1995 and will increase by years (thousands of units); 1995 — 50,000; 1996 — 100,000; 1997 — 150,000; 1998 — 200,000

Funding and Cost Recovery Period

The approximate amount of the investment required for implementing the work program is 2.5 million dollars.

Funding is to be by an advantageous loan for 3 years.

If the planned volumes of production are met the total recovery of the investment will be attained in 1997. The time required for full repayment of the loan (with interest taken into account) will be the first half of 1998.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Standard Production of Microwave Mixing Diodes With Three- Dimensional Potential Barriers

Mixing and detector diodes of a new generation based on homo- and heteroepitaxial structures have a number of advantages in comparison with Schottky diodes: possibility for flexible control of height of barrier and degree of asymmetry of the volt-ampere characteristic,

weak dependence of parameters on mixing and temperature and increased electric strength. They will find application in different types of radio receiving equipment, including wide-band, balance, multibalance and multichannel mixers, subharmonic mixers, receiving antenna arrays with low power consumption, wide-band detectors of control-measuring instruments and other types of electronic radio equipment.

Technical Specifications

$F_{[illegible]}$ 7.5 dB; Pr = 0.3 mW; Ptg = -53 dBm (without mixing); $F_{[illegible]}$ = 15 GHz; $F_{[illegible]}$ = 50 GHz; βv 3000 V/W.

Work To Be Done Within Scope of Project

- Development of standard production.
- Development and fabrication of technologic equipment.
- Acquisition of technologic and test equipment.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of diodes can be initiated in 1995 and will increase by years (thousands of units): 1995 — 50.000; 1996 — 100,000; 1998 — 200,000

Funding and Cost Recovery Period

The approximate amount of the investment required for implementing the work program is 2.5 million dollars.

Funding is to be by an advantageous loan for 3 years.

If the planned volumes of production are met the total recovery of the investment will be attained in 1997. The time required for full repayment of the loan (with interest taken into account) will be the first half of 1998.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Development and Production of Powerful Microwave Switching Diodes

Powerful switching diodes are intended for use in high-speed switches, modulators, phase inverters operating in the microwave and EHF ranges as part of systems for satellite communication, data transmission, microwave TV, in medicine and in a number of types of industrial equipment. The proposed diodes will make it possible to increase the power characteristics and speed of modulators, phase inverters, switches and limiters and to broaden the range of their application.

Technical Specifications

Work To Be Done Within Scope of Project

- Development of standard production.
- Development and fabrication of technologic equipment.
- Acquisition of technologic and test equipment.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of diodes will be initiated in 1995 and will increase by years (thousands of units): 1995 — 12,000; 1996 — 15,000; 1997 — 20,000; 1998 — 25,000.

Funding and Cost Recovery Period

The approximate amount of the investment required for implementing the work program is 3.5 million dollars.

Funding is to be by an advantageous loan for 3 years.

If the planned volumes of production are met the total recovery of the investment will be attained in 1997. The time required for full repayment of the loan (with interest taken into account) will be the first half of 1998.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Creation of Discrete and Combined Ultrastable Certified Precision Stabistors

The instruments are intended for use as a source of d-c reference (standard) voltage in precision command instruments of electronic control and navigation systems of space, aviation and sea electronic equipment, precision measuring instruments of a higher accuracy (emf standards, voltage and current calibrators, digital voltmeters), precision electronic equipment for economic purposes, including automated systems for the control of technologic processes in metallurgy, power plants, including the power units of nuclear power plants, complex diagnostic medical instruments and life support systems.

Technical Specifications

Stabilization voltage — 6 and 9 V

Stabilization voltage temperature coefficient — 0.0005-0.00005 percent °C

Long-term stabilization voltage stability — 0.0005-0.0002 percent per year (9,000 hours)

Low-frequency noise voltage (frequency range 0.01-1 Hz) — 0.00005 percent U_{st}

Work To Be Done Within Scope of Project

- Development of design and technology for development of UAPS.
- Development and organization of deliveries of highly doped (0.003-0.01 ohm cm) resistant silicon of p and n types of conductivity with increased resistance to external destabilizing factors with dispersion of nonuniformity of resistivity not greater than +/-3-5 percent.
- Development and fabrication of ultraprecise metrologic systems for checking and monitoring UAPS parameters.
- Development and fabrication of technologic and test equipment and accessory items for UAPS production.
- Preparations for and organization of UAPS production.

Times and Volumes

The production of a number of typonominals can be initiated in 1966 and increased by years (thousands of units): 1996 — 5.0; 1997 — 15.0; 1998 — 25.0.

Funding and Cost Recovery Period

The approximate amount of funding for implementing the work program is 5.6 million dollars. Funding is to be by an advantageous loan for 3-4 years. If the planned volumes of production are met the total recovery of the investment will be attained in 1998. The time required for repayment of the loan (with interest taken into account) in 1988.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Development and Production of Integrated Precision Stabistor and Reference Voltage Sources

New low-voltage micropowerful integrated precision stabistors, microcircuits for temperature sensors and precision reference voltage sources for equipment to be used for economic and special purposes.

The instruments are intended for use as d-c reference voltage sources in measuring devices, precision electronic equipment with limited power consumption, computer input-output units, instruments for diagnosis and checking of medical equipment, radiotelephones, electronic nits for control of motion picture photographic equipment, highly precise digital-to-analog and analog-to-digital converters, temperature sensors, portable electronic equipment for special purposes, etc.

Technical Specifications

Stabilization voltage (reference voltage) — 1.2, 2.5, 5.0,

10 V Range of working currents — 0.1-10 mA

Differential resistance — 1-2 ohm

Temperature coefficient — up to 0.0020 percent °C

Long-term voltage stability — not worse than 0.005 percent in 1,000 hours

Error in determining temperature — not worse than 0.5-1°C

Work To Be Done Within Scope of Project

- Development of circuitry and technologic construction of items, CADS.
- Development of design and technology for the production of stabistor microcircuits and ION temperature sensors.
- Development and fabrication of technologic and precision control- measuring and test equipment for production of microcircuits.
- Development and production of housings and microcarriers.
- Supply of production with epitaxial structures with latent layer.
- Preparations for and organization of production of items.

Times and Volumes

The production of a number of typonominals can be initiated in 1995 and increased by years (thousands of units): 1995 — 100.0; 1996 — 500.0; 1997 — 1,000.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program is 4.4 million dollars. The form of funding is an advantageous loan for 3 years.

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The time for beginning repayment of the loan (with interest) is the fourth quarter of 1997.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Development and Production of High-Quality Varicaps

A new generation of high-quality silicon varicaps intended for the channel selectors of television and video

equipment accomplished by the technique of surface mounting of components.

The good prospects for the indicated selectors are related to their new functional capabilities and broadened consumer properties.

The key elements of the new selectors are varicaps for surface mounting.

Technical Specifications

Range of working frequencies — 40-1,000 Hz

Varicap capacitance at 28 V — 0.8-3.4 pF

Quality — 100-700 units

Coefficient of capacity overlapping — 8-20 units

Housing of type KT-46, KD-36 (Sod-123, Sod-323 analogue) — miniaturized, plastic for surface mounting on board

Work To Be Done Within Scope of Project

- Development of design and technology for production of miniaturized plastic housings for surface mounting.
- Development and acquisition of silicon epitaxial structures on KEM 0.003 backing with rigorous tolerances for thickness and concentration of epitaxial layer.
- Development and fabrication of technologic, control-measuring equipment and fittings for production of varicaps.
- Computer designing of a series of varicap typonominals.

The production of a number of typonominals can be initiated in 1995 and will be increased by years (thousands of units): 1995 — 100; 1996 — 500; 1997 — 1,000.

Funding

The approximate amount of investment required for implementing the work program is 3.3 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The total repayment of the loan with interest will be in the fourth quarter of 1997.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Teletype Moscow "Silan"

Project. Development of Photodetectors Based on Charge-Coupled Instruments for Special Television Information Systems

Solid-state linear and matrix photosensitive instruments with charge coupling are intended for use in special TV systems operating in the visible, UV, near- and far-IR wavelength ranges.

A distinguishing feature of the project is the development of new types of photodetectors optimized for different types of apparatus which in its technical-economic parameters is competitive with or ahead of the world level.

Technical Specifications

	Number of elements	Audio frequency, MHz
Linear PSCCI	up to 2,048	up to 20
Linear PSCCI	up to 5,048	up to 30-40
Matrix PSCCI	500 x 576	TV standard
Matrix PSCCI	700 x 576	TV standard
Matrix PSCCI	1,200 x 576	small-format TV
Matrix PSCCI with time lag and accumulation	conforming to technical requirements on equipment	conforming to technical requirements on equipment
Integrated circuits for control of PSCCI and converters of level of controlling signals	switching of entire information field	conforming to technical requirements on equipment

The new instruments ensure development of: aerospace instrument making for remote sounding of Earth's surface for ecologic monitoring, control of rational use of the environment, prevention of development of exceptional situations and catastrophes;

medical X-ray equipment with irradiation dose reduced by a factor of 10, uncooled thermal imaging for early diagnosis of cancer and different types of small highly sensitive endoscopes;

technical portable TV equipment ensuring detection of gaps in thermal paths, ruptures in gas and oil pipelines and subsurface peat fires;

precision phototransmitting dactyloscopy equipment for increasing safety, etc.

The indicated types of photodetectors are virtually lacking on the world market.

Work To Be Done Within Scope of Project

- Further development of the entire complex of cooled and uncooled linear and matrix PSCCI and electronic integrated circuits for their control and signal processing;
- Organization of standard production of PSCCI;
- Development of special technologic and measuring equipment for standard production;
- Metrologic and certification testing;
- Organization of warranty servicing and training of users.

Funding

The required amount of funding is 6 million dollars.

The development and putting of the special elemental base for photodetectors into production will make it possible to create highly efficient equipment for different fields of application: medicine, the economy, transportation, heavy industry, nuclear power, geology, agriculture, space technology, safety and preservation of public order systems. The sums spent on developing the elemental base will pay for themselves multiply in 3-5 years.

Pulsar State Scientific Research Institute Telephone: 369-04-81 Fax: 366-55-83 Teletype: Moscow "Gibrid"

Project. Development of High-Temperature and High-Voltage Semiconductor Diodes

The project calls for the development of Schottky diodes (and diode matrices) based on wide-band (GaP, SiC) semiconductors and high-speed columns with improved economy.

Due to the use of the latest advances in the materials field (Physical Technical Institute imeni A. F. Ioffe, MV Scientific Research Institute, Microelectronics Technology Scientific Research Institute) the Schottky diodes ensure the needs of high-temperature e..ctronics (180-350°C for aerospace objects, 300-600° for geological prospecting work).

The development of high-speed columns will make it possible to increase the economy and reliability of TV multipliers, and with an increase in $U_{rev.\ max}$ to 25-30 V will make it possible to eliminate this unit completely in new-generation TVs.

Technical Specifications

Schottky diodes $U_{rev.\ max}$ — 100-800 V

U_{dir} — 2.2-5.0 V

$I_{dir.\ max}$ — 0.1-10 A

f_{lim} — 0.5-5 MHz

Θ_{work} — 200-600°C

High-speed high-voltage columns

$U_{rev.\ max}$ — 10-30 kV U_{dir} — 5-12 V

I_{dir} — 5-50 mA

t_{com} — 20-100 ns

Work To Be Done Within Scope of Project

- Development of technologies for wide-band materials for Schottky semiconductor diodes and fabrication of p-n transitions, including special equipment.
- Development of high-temperature diode housings.
- Development of technology for assembly and testing of high-temperature diodes.
- Development of designs and technologies for high-voltage columns on basis of two-layer epitaxial structures and use of passivation by special glasses.

Times and Volumes

The production of instruments can be initiated in late 1995 and will increase in thousands of units.

	Schottky diodes	High-speed high-voltage columns
1995	opt. consignment (1,000 units)	opt. consignment (1,000 units)
1996	3-5	10-20
1997	5-10	200-300
1998	20-30	1,000-3,000

Funding

The approximate amount of investment is: for point 1.1. — 300 thousand dollars (in ruble equivalent) for point 1.2. — 400 thousand dollars — during 1995-1996.

The form of funding is an interest-free loan for 2.5 years.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone: 369-30-36 Fax: 365-15-52 Teletype: Moscow "Silan"

Project. Development and Production of Powerful Silicon Switching Transistors for Power Electronics

The project provides for the development and production of a new generation of powerful silicon bipolar and field transistors and their structural combinations in the following directions:

Powerful MDS transistors with a p and n channel.

Powerful bipolar transistors with an insulated gate (BTIG) Powerful bipolar transistors with static induction (BSIT) with gate in form of a p-n junction and insulated gate.

In addition, the program, on the basis of the enumerated elemental base, provides for the development and production of a wide range of functional modules, assemblies and integrated circuits.

These devices are of enormous importance for all branches of the economy because there is a substantial simplification of the conversion of an alternating current with a frequency of 50 Hz into a higher-frequency current and make it possible to solve this problem for high-power devices (up to hundreds of kVA). The use of such devices in secondary power sources and in power electrotechnical plants are capable of ensuring an enormous saving of electric power, copper, electrotechnical steel and corresponding material, energy and work resources in their production.

Technical Specifications

The planned work corresponds to and in some cases also is superior to the foreign technical level.

The planned price is lower than the prices of similar foreign items by a factor of 1.5-2.

During 1996-2000 plans call for the standard production of items with the following parameters.

Work To Be Performed Within Scope of Project

- Development and putting into production a new generation of powerful silicon switching transistors with an increased level of energy indices and increased reliability indices.
- Development of new promising materials, including multilayer epitaxial structures with a buffer layer and multilayer structures obtained by the thermal sintering method.
- Development of production with a reduced labor input in technological processes and high ecologic safety.

The program is intended to run to the period up to 2000.

The volumes of production will be determined by the requirements of the economy and the capacity of the domestic and foreign markets.

With allowance for the needs of the electrical engineering industry, auto transport and the long-term development of the telephone network the annual need must be from 150 million units per year in 1996, up to 1 billion units in 2000.

The amount of expenditures under the program during 1995-2000 is 100 million dollars.

Taking into account the requirements for the developed instruments, the programs must pay for themselves economically as quickly as possible.

Manufacturers: Pulsar State Scientific Research Institute, Elektronpribor Joint-Stock Company, Oktava Joint-Stock Company, Eldag State Enterprise, Iskra State Enterprise, Elkor Production Association, Kremniy Joint-Stock Company, Eleks Joint-Stock Company Telephone 369-04-81 Fax 366-55-83 Teletype Moscow "Gibrid"

Project. Hybrid Functional Power Modules

Development of the design and technology for the manufacture of powerful switching instruments with field control of modules for high-voltage electronic switches based on them and organization of the industrial production of these items.

High-voltage electron switch modules (HVESM) are intended for use as highly sensitive electronic relays and as the power switches in devices for controllable electric drive, especially on the basis of electric motors without collectors.

HVESM combine positive qualities of a thyristor (high working voltage, resistance to power surges, small losses in an open state) with a high response and speed of the MDS transistors. In their principal parameters they are not inferior to the power modules of foreign companies.

Technical Specifications

Working voltage — not less than 600 V

Switched current — not less than 10 A

Control voltage — not more than 25 V

Voltage in open state — not more than 1.2 V

Approximate price — 12 dollars

Work To Be Done Within Scope of Project

- Development of design and technology for active electronic equipment items making up the HVESM
- Determining the circuitry layout of the MVESM and development of its design and manufacture technology
- Development and fabrication of technologic fittings
- Acquisition and fabrication of control-measuring equipment for the testing of electronic equipment items and the HVESM as a whole.
- Preparations for standard production.

Times and Volumes

The production of HVESM can be initiated in 1996 and increased by years (thousands of units):

1996 — 30;

1997 — 500;

1998 — 800.

Funding

The approximate amount of investment required for implementing the work program is 500,000 dollars. The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

If the stipulated volumes of production are met the total repayment of the loan with interest is before the end of 1977 (1 year).

Svetlana Joint-Stock Company, St. Petersburg Telephone: (812) 554-93-68 Fax: (812) 554-03-71.

Project. Pulsed Switching and Protective Gas-Discharge Instruments

Development and standard production of:

Miniaturized button dischargers for a voltage from 80 to 10,000 V.

Thyratrons with a cold cathode based on a pseudospark discharge

Controllable gas discharge instruments.

The instruments are intended for automatic electronic telephone offices, computers and faxes.

Technical Specifications

The instruments have original technical designs. The dischargers, peakers and tacitrons — thyratrons with a fine-structured grid — have no foreign analogues.

Volumes

In 1994 16 types of thyratrons and tacitrons (of which 4 are in standard protection and the others by special order) and 48 types of discharger (of which 27 are of a button design)In 1995 the prediction is for an increase in the volumes of production of GDCI for both export and for Russian consumers.

Plazma State Electronics Production Scientific Research Institute, Ryazan

Project. Powerful Semiconductor Thyristors

The project provides for the development of powerful blocking thermistors with a voltage not less than 1200 V and a current up to 200 A and the organization of their standard production.

Powerful blocking thyristors (PBT) are intended for use in new-generation systems for controllable a-c electric drive, especially for city trolley cars with an a-c current drive having a high reliability, simplicity of operation and increased economy.

The new types of PBT have higher dynamic parameters and a blocking factor than those produced in the Ukraine and Estonia and with respect to their technical parameters are at the level of the best foreign instruments.

Technical Specifications

Working voltage — not less than 1,200 V;

Pulsed blocking current — not less than 200 A;

Average current — not less than 40 A;

Blocking factor — not less than 5;

Approximate price — 15 dollars.

Work To Be Done Within Scope of Project

- Development of design and technology for manufacture of instruments.
- Development and fabrication of technologic equipment.
- Acquisition, development and manufacture of necessary technologic, control-measuring and test equipment.
- Conducting tests and certification of instruments.
- Preparations for and organization of standard production.

Times and Volumes

The standard production of PBT can be initiated in 1996 and by years will be:

1996 — 20;

1997 — 60.0;

1998 — 80.

Funding

The approximate amount of investment required for implementing the work program is 250,000 dollars. The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

If the planned volumes of production are met the recovery of cost can be attained by late 1997. The time of repayment of the loan with interest is the first half of 1998.

Svetlana Joint-Stock Company, St. Petersburg. Telephone: (812) 554-93-68. Fax: (812) 554-03.71.

Optoelectronic Instruments for Optical Reception, Processing, Transmission and Display of Information

O. R. Abullayev, V. S. Abramov, Yu. F. Lezzhov, V. P. Sushkov and N. N. Usov

Optoelectronics occupies a special place among instruments and devices in the field of semiconductor microelectronics. Systems for display of the state of equipment for the display of different kinds of information in electronic radio equipment, in aviation and space technology, equipment for transportation and communication, moving lines and information screens, displays of foreign exchange rates, remote control and safeguarding of objects against unauthorized access, optoelectronic microcircuits for the switching of logic signals, optoelectronic sensors for medicine, physical culture, sport, optoelectronic devices for measuring different physical parameters, reliable, high-speed, noise-immune local fiber optic lines for the transmission of information and high-voltage decouplings, printer heads and readout devices, systems for observation, targeting and surveillance, registry of on-line aerospace information on data media, optical sights and complexes for automated flight control — this is by far an incomplete list of the fields of application of optoelectronic instruments.

A distinguishing feature of optoelectronic instruments is the feature that despite such fields of application so different in their functional purposes, at their basis there are the same initial semiconductor materials, basic technologic processes, standardized designs, same technologic, measuring and test equipment and same system of parameters.

Such a broad application of semiconductor optoelectronic instruments is attributable to the unique combination of their parameters:

- possibility of producing any glow color from violet to the near-IR;
- complete compatibility with respect to levels of controlling signals with standard integrated control circuits and microprocessors and accordingly, inexhaustible possibilities with respect to microminiaturization and decrease in dimensional indices of the device as a whole;
- high degree of reliability and guaranteed useful life not less than 50,000-100,000 hours;
- high speed, making possible rapidly changing information virtually in real time;
- resistance to climatic, mechanical and special impacts of destabilizing factors relative to the most rigorous standards used in surface, air- and

seaborne equipment, and as a result, development of instruments and devices for any application;
- possibility, using the same hardware and software and constructively the same technologic principles, to create information display instruments from those for individual use (with a resolution to 300 lines/cm) to enormous collective-use information panels in stadiums and display of highway information (with a resolution up to 2 lines per centimeter).

The Russian optoelectronic instruments which have been developed and manufactured are in no way inferior in their parameters to the best foreign variants, and in some classes are even superior to them (for example, emitting diodes, receiving-transmitting modules of fiber-optic communication lines and multielement image shapers for IR TV equipment and registry of aerospace information).

The principal paths of development of optoelectronics in the Russian Federation have been approved by the Russian State Program for the Development of Electronics Technology.

The principal scientific objectives to be met within the scope of the Program are:

- creation of optoelectronic instruments in a broad spectral range (from the violet to the near-IR) and obtaining sources of white light with a light conveyance exceeding the light conveyance of incandescent bulbs in a comparable spectral range;
- creation of intellectual instruments integrating the functions of electric and optical reception, processing and transmission of information.

The practical objective of the Program is to meet economic needs in the necessary volume and variety with modern competitive optoelectronic instruments to a considerable degree determining the technical level of the devices in the most important fields of human activity.

Information Science and Control

On the basis of highly efficient light-emitting diodes of different designs and glow colors from violet to the near IR, controlled by semiconductor symbol-synthesizing indicators and modulators it is possible to ensure the creation of full-color, multifunctional and intellectual information display systems up to screens for collective use (resolution up to 2-5 lines/cm) and individual use (30-300 lines cm)

Examples of the use of the first type of screens is various kinds of multicolor moving lines and panels used in transmitting advertising or other programs. An example of use of screens of the second type is a symbolic-graphic screen with a resolution up to 30 lines/cm for the display, for example, of flight information or a unique miniaturized color monitor with a resolution up to 300 lines/cm for use in a portable computer, pocket fax, electronic notebook, medical equipment, etc.

Industry, Transportation

The use of a broad range of optoelectronic instruments for indicating the state of objects, remote control and control of technologic processes in automobiles, for creating luminescent symbols with a large illuminated area, warning lights on radio towers, beacons and airfield landing strips.

Communication, Computers

Intrafacility fiber optic lines for the transmission and reception of information at rates up to 144 Mbit/s with a digital or analog output, repeaters of an optical signal, multichannel multiplexers (demultiplexers), optoelectronic modules for the input and output of information, optoelectronic lines for data transmission, system for remote control and protection against unauthorized access, printer heads, monolithic matrices for image identification and optoelectronic readout devices, optoelectronic relays for constant and alternating currents for use in switching devices of onboard and surface equipment, telephony and computer equipment.

Aerospace Technology, Special Applications

Pilotage-navigation equipment for flightcraft, fiber optic lines and optoelectronic transducers for prelaunch control, systems for on-line registry of aerospace information on photosensitive material, television instruments, informational multifunctional screens, radiationally resistant instruments and optoelectronic relays.

Medicine, Physical Culture, Sports, Ecology

Light-emitting diodes with violet and blue colors of glow and optoelectronic transducers for monitoring of harmful substances in gas and liquid media.

The use of optoelectronics instruments in comparison with other classes of instruments makes it possible to reduce the expenditure of energy and materials by a factor of not less than 100, to increase reliability by a factor of not less than 5-10, preclude harmful radiations on the operator, create systems for optical reception, processing, transmission and display of information, completely compatible with respect to controlling voltage and current, competitive on the world market.

Project. Standard Production of Wide Variety of Optoelectronic Instruments

Optoelectronic instruments, microcircuits and devices based on them are intended for the processing and readout of information, image formation and control, as well as use as optoelectronic switches for TV and telephonic communication and output-input devices. The proposed optoelectronic instruments are in no way inferior to the best foreign analogues and are competitive on the world market.

Provision is made for the development of technology and the organization of standard production of:

Optoelectronic instruments with open optical channel of the slit and reflection types, including with control circuits at the output.

Optoelectronic relays operating on a direct and alternating current.

Optoelectronic instruments for high-voltage galvanic decoupling.

Solid-state photoelectronic converters for the readout of information and identification of images.

Optoelectronic sensors of different physical parameters, exposure meters, higher-class optoelectronic systems for control of motion picture equipment.

Technical Specifications

Monolithic optoelectronic matrices for identification of images on light reflection principle
Resolution — 10-20 μ
Response — signal/noise ratio 5

Optoelectronic instruments with open optical channel
slit type
Optical gap — 1.5-7 mm
Diaphragm — 1.8 - 0.075 mm
Input current — 10-30 mA
Output current — 0.1-3 mA
Resolution — more than 50 μ
reflecting type
Input current — 10-30mA
Output current — 0.1-1.5 mA
Resolution — more than 50 μ

Optoelectronic relays of constant and variable type
Switching current — 0.1-10 A
Switching voltage — 30-600 V

Optoelectronic high-voltage galvanic decoupling microcircuits
Insulation voltage — up to 30,000 V
Input current — 10 mA
Switching voltage — 50-300 v

Devices (transducers) based on slit optrons make it possible to perform remote readout of different kinds of information at a distance up to 100 m from the object with a reversible mode. The transducers ensure operation in any branches of industry, transportation and communication, including under conditions with a danger of explosions.

Work To Be Done Within Scope of Project

- Development and fabrication of special technologic and control-measuring equipment.
- Acquisition of technologic and test equipment.
- Organization of standard production.

Times and Volumes

The production of optoelectronic instruments by years will be (thousands of units): 1995 — 900; 1996 — 3,000; 1997 — 6,000; 1998 — 20,000

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program is 3.5 million dollars. The form of funding is an advantageous loan for 3 years.

If the stipulated volumes of production are met the total recovery of the investments will be attained in 1997. The time for full repayment of the loan with interest is the first half of 1997.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone: 369-30-36 Fax: 365-15-52 Telex: SILAN

Project. Standard Production of Emitting and Photodetecting Diodes Operating in IR Range

Emitting and photodetecting diodes ensure the transmission and reception of optical radiation at wavelengths, make it possible to transmit optical information via fiber with minimum losses over great distances with a lesser number of repeater points.

The emitting diodes with a radiation power up to several watts are used for creating highly efficient protective optoelectronic systems, systems for remote control of equipment and wireless transmission of information over great distances.

Receiving and transmitting modules and fiber-optic transmission system (FOTS) repeaters, having a high limiting rate of data transmission — up to 140 Mbit/s and capable of operating in the entire range of rates from 0 to 140 Mbit/s — are characterized by universality and can replace up to 4 classes of terminal FOTS devices overlapping the range in different sectors.

Linear image shapers with built-in control make it possible to create compact devices for the reproduction of graphic high-resolution information in systems for computer graphics, television, mapping of areas, etc.

Provision is made for the development of a technology and the organization of standard production of:

Diodes emitting in the IR range for high-speed fiber optic data transmission systems (FOTS).

High-speed photodetectors for high-speed FOTS.

Powerful emitting diodes operating in the IR range for open optical data transmission systems.

Receiving and transmitting modules and repeaters for high-speed FOTS.

linear image shapers with built-in control for photoregistry, thermal imaging and printing equipment.

Technical Specifications

Emission wavelength of diodes — 0.85, 1.3 and 1.55 μ

Modulation frequency up to 150-200 MHz

Radiation power of high-speed diode up to 1 mW and above

Radiation power of powerful IR light-emitting diode — greater than 1 W ($\lambda = 0.85\ \mu$)

Range of wavelengths of photodetecting diodes — 0.8-1.6 μ

Response — 0.4-0.6 A/W, rate of received information — up to 2 Mbit/s

The receiving and transmitting modules ensure a rate of data transmission in the range 0-140 Mbit/s, energy potential in a line — up to 30 dB.

The linear image shapers ensure a resolution 10 lines/mm and make it possible to shape the image in the formats A3, A4, ensuring a light intensity up to 120 μkd per pixel and a rate of data registry up to 100 Mbit/s.

Work To Be Done Within Scope of Project

- Development of a technology for large-scale production.
- Development and fabrication of technological equipment.
- Acquisition of technological and test equipment.
- Preparation for and organization of production.
- Metrologic and certification testing of production.

Times and Volumes

The production of optoelectronic instruments can be initiated in 1994 and will increase by years (thousands of units): 1994 — 50; 1995 — 1,000; 1996 — 1,300; 1997 — 2,000.

Funding and Cost Recovery Period

The approximate amount of investment necessary for implementing the work program is 2.5 million dollars. The form of funding is an advantageous loan for 3 years

If the stipulated volumes of production are met the total recovery of investment will be attained in 1996.

The time for total repayment of the loan with interest is the first half of 1997.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Telefax SILAN

Project. Development of Highly Efficient Semiconductor Indicators and Display Systems

The instruments are intended for use in information systems, industry, transportation, communication, aerospace technology and household electronic appliances.

Provision is made for the development of:

A technology for highly efficient SID crystals emitting in a broad spectral range (from the violet to the near-IR) on the basis of semiconductor structures ensuring a high internal and external quantum yield of electroluminescence for the purpose of creating powerful light sources in light output superior to an incandescent lamp in the comparable spectral range.

There is a broad range of highly efficient semiconductor indicators: unit, digital-letter, matrix and scale screen modules, "intellectual" instruments, integrating, electric and optical reception, processing, transmission and display of information.

Data display systems (with a resolution for individual (with a resolution up to 300 lines/cm), group 2.5-10 lines/cm) and collective (up to 2 lines/cm) use, including digital and symbolic panels, mnemonic and analog schemes, graphic screens (including multicolor).

Technical Specifications

Specific light intensity — 100-600 μkd/mA Color of luminescence — violet, blue, emerald, green, yellow-green, yellow, orange, red.

Work To Be Done Within Scope of Project

- Improvement in initial semiconductor structures and technologies for obtaining SID structures.

- Choice of design solutions, development of manufacture designs and technology.
- Development of manufacture of technological and control-test equipment.
- Organization of standard production.

Times and Volumes

Production of optoelectronic instruments by years (thousands of units): 1995 — 10; 1996 — 25; 1997 — 400.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program is 10 million dollars. The form of funding is an advantageous loan for 3 years.

If the stipulated volumes of production are met the investment will be paid off in 1997.

The time for complete repayment of the loan with interest is the first half of 1998.

Project. Development of Highly Efficient Silicon Carbide Light-Emitting Diodes

Silicon carbide instruments emitting in the green, blue and violet spectral regions are used for developing full-color displays and screens for individual and collective use. The instruments are used in instrument making, aerospace technology and medicine.

Technical Specifications

Radiation light intensity ... 5-30 μd

Direct voltage ... 3-4 V

The maximum of the spectral distribution of radiation is purely green, blue and violet luminescence corresponds to 525,480 and 440 mm.

Work To Be Done Within Scope of Project

- Development and fabrication of special technological equipment.
- Acquisition of technological and test equipment.
- Preparation for and organization of production.
- Metrologic and certification testing of production.

Times and Volumes

The problem of light-emitting diodes with blue, purely green and violet colors of luminescence can be initiated in 1994 and increase from year to year (thousands of units): 1994 — 3; 1995 — 50; 1966 — 300; 1997 — 2,000.

Funding and Cost Recovery Period

The approximate amount of the necessary investment for implementing the work program is 1.6 million dollars. The form of funding is an advantageous loan for 3 years.

If the stipulated volumes of production are met the investment will be completely recovered in 1996.

The time of complete repayment of the loan with interest is the first half of 1997.

Sapfir Scientific Production Enterprise Joint-Stock Company Telephone 369-30-36 Fax 365-15-52 Telex SILANy

Information Display Instruments

V. N. Ulasyuk, doctor of physical and mathematical sciences, fill member RF Academy of Technical Sciences and RF Institute of Automation, professor

Information display instruments, which constitute the basis for an enormous number of consumers goods in wide demand and which occupy the leading place after microelectronics, are acquiring special prospects for the Russian electronics industry.

The producers of Russian kinescopes must solve the vitally important problem of the buildup of volumes of production, in 1993 attaining 4 million color and 2 million black-and=white kinescopes for TVs, and also organize the standard production of color display kinescopes for personal computers.

This requires, first of all, the reoutfitting of the glass production facilities of kinescope plants with equipment for the production of glass sheaths with a flattened surface and with straightened screen corners. The production of TVs is continuing to grow. A the present time a technical revolution is occurring in the electronics of information display which is associated with the replacement of traditional vacuum cathode-ray tubes (kinescopes) by flat screens with a high information- conveying capacity.

The production of flat screens is characterized by expenditures of material and power less by a factor of 100, relatively inexpensive materials, absence of production of many tons of costly rare earth luminophors, special highly precise rolled steel, copper wire for deflecting systems, as well as enormous volumes of glass containing lead and strontium.

Flat screens are ecologically safe, which makes it possible to use in schools flat color monitors which in some cases ensure a better image quality than color kinescopes.

The changeover to fundamentally new information display instruments will enable producers of computers and household electronics to increase sharply their competitiveness on the world market.

Great prospects for solving the problem of wall-mounted wide-format TVs with a diagonal 0.5-1.0 m (including high-clarity TV) are linked to development work on color plasma panels.

Flat screens with autoelectronic emission — an analogue of cathode-ray tubes with matrix addressing in which a large number of cold microcathodes replaces one incandescent cathode merit particular attention. Indicators with autoelectronic emission are characterized by a high brightness, have high performance in a wide temperature range and are resistant to ionizing radiation.

There are still unsolved problems involved in the manufacture of flat full-color thin-film electroluminescent screens, primarily to the lack of a triad of highly efficient electroluminophors.

Now in world practice the widest use is being made of passive-matrix liquid-crystal screens based on the supertwist effect with multiplex control. The market for color AMLCS with an active matrix on the basis of thin-film transistors (AMLCS) is developing at a rapid rate.

In the future active-matrix technology may become so universal that in a single technologic cycle it will be possible to manufacture on a common glass backing up to 80 percent of the structure of future microcomputers: active AMLCS, screen and keyboard drivers and controllers, etc, and also use AMLCS in a touch screen mode.

Thereby the monopolistic ownership of this technology would allow control of the future computer market.

The institutes of the State Committee for the Defense Industry have successfully carried out development work on the first Russian flat screens: plasma panels with a diagonal of 27 cm for laptops, have developed a dimensional-parametric series of monochromatic super-twisted LC screens with a diagonal up to 30 cm and have organized the production of screens for portable laptops, measuring and medical instruments.

A technology for color AMLCS with diagonals 6, 10, 17 and 20 cm has been developed and development work is being carried out on all the components necessary for their production, including lighting sources, the first Russian automated line and a unique "clean room" of cleanness class 10-100, which already in 1995 will make it possible to establish pilot production of color AMLCS with an output of 30,000-50,000 screens each year.

Using this pilot line it will become possible to carry out development work on color large-format AMLCS with a diagonal up to 50 cm and the technology and equipment will be perfected which are necessary for mass production, which it is proposed be organized in 1997 in a projected plant, reaching a production of 500,000 units annually in 1998. In the new production facility, whose construction is being carried out at the Volga Scientific Research Institute, standard production will be organized for monochrome LCS with the production reaching 500,000 units. The short period for the recovery of capital investment in these production facilities (not more than 3 years) is determined by the fact that their production has a clearly expressed foreign exchange-replacing character because the cost of an AMLCS is 60 percent the cost of a laptop and 50 percent of the cost of a pocket TV. The saving of foreign exchange in the construction will be more than 300 million dollars. The standard production of color plasma panels will be organized at a plant under construction at the Plazma Scientific Research Institute with production reaching 100,000 units annually.

In order to manufacture color LCS with a high information content there must be well-developed production of all the necessary components: liquid crystal mixes, substrates of high-quality glass, polarizers and dyes for color light filters, integrated circuits for drivers and special technologic equipment.

The corresponding development work and the organization of production are provided for at a number of enterprises of the State Committee for the Defense Industry and the chemical industry, at which pertinent scientific work has already been done and where experimental production has been initiated.

The Russian State Program for the Development of Electronic Technology has provided for the organization in Russia of an industry for the production of flat information screens and saturation of the Russian with high-technology goods in wide demand which are competitive on the world market.

Simultaneously with flat screens, work is being done on 6 basic models of pocket and portable color and black-and-white TVs with screens having diagonals 10, 14, 20 and 25 cm, laptops and notebooks with monochrome and color screens with a diagonal 20 and 25 cm, automobile displays, TVs built into the seats of passenger aircraft, intercoms, color TV projectors with screens having a diagonal 1-1.5 m, flat wall-mounted color TVs based on gas-discharge panels with a diagonal of 60 cm, electronic games, etc. Their standard production is being organized by existing assembly facilities of a number of

enterprises of the radio industry, communication equipment industry, aviation and shipbuilding industries.

Ergonomic and certification support provides for the drawing up of norms, requirements and state standards harmonized with international standards, setting up of an agency for the certification of information display instruments and development of special metrologic equipment.

The resources made available for program implementation will be adequate in appropriate subprograms for a complex of development work and practical use of new materials, special technologic equipment, completion of construction of two new production buildings in Saratov (20,000 m^2) and Ryazan (24,000 m^2) and construction in Fryazino of a production building for AMLCS with a total area of 12,000 m^2, including "clean" rooms of class 10-100 with an area 2,400 m^2.

The funding of the program for 1993-2000 will be 106.7 billion rubles in the prices of 1993, including for scientific research and design work — 60.8 billion rubles and for the development of the scientific-technical and production base — 45.9 billion rubles.

Funding of scientific research and design work: from sums in the republic budget — 50.5 billion rubles, from client sums — 10.3 billion rubles.

Funding of capital investments: from sums from the republic budget — 20.7 billion rubles, from loans — 10.7 billion rubles and from the resources of the enterprises themselves — 12.3 billion rubles.

Project. Dual-Purpose Flat Information Screens and Intellectual Consumer Goods Based on Them

Passive matrix monochromatic and color liquid-crystal screens.

Diagonal from 10 to 30 cm with multiplex control for compact and inexpensive personal computers of the Notebook and Laptop types, measuring and medical equipment, navigation system, industrial equipment and pocket TV games.

The information capacity of the screens is from 64 x 80 to 640 x 480 elements, brightness contrast 10:1.

Full-color active liquid crystal (LC) screens with diagonal lengths 6, 10, 14, 20, 25, 40 and 50 cm for pocket, portable and wall TV sets, projection TVs and monitors, personal microcomputers of the Notebook type, monitors of instrument panels of all types of flightcraft and automobiles, etc. Information capacity from 288 x 480 to 1,024 x 768 elements in accordance with the standards of TV and display, including aviation screens. Contrast up to 20:1, 16 brightness gradations. Range of working temperatures from -60 to +70°C.

Gas-discharge flat screens with diagonals 60 and 100 cm for flat TV sets, monitors of personal computers and assembled panels for large-format information boards. Information capacity for TVs from 768 x 576 to 1,920 x 1,152 elements (TV frequency standard), for large (diagonal 6 m) screens — 768 x 576 elements. Brightness — up to 150 kd/m^2.

Vacuum luminescent indicators with storage cathodes for displays, vehicles, household equipment, TV equipment and large assembled color screens for collective use (a total of 8 typonominals). Information capacity from 128 x 128 to 576 x 768 elements. Areas of large screens from 10 to 100 m^2.

Flat screens based on matrix cold cathodes. A subprogram provides for conduction a variety of research and practical studies for developing screens for TVs and personal computers> Plans call for developing black and white TV screens with a diagonal up to 16 cm by 1997 by 1997 and color screens by 2000.

The following work will be done within the scope of the project:

— development of design and technology for production of flat screens of about 30 types and sizes;

— development of copies of goods with use of flat screens (TV sets, microcomputers, TV games, intercoms, safety signaling devices), instrument panels for modern flight craft and vehicles;

— microcircuits and elements for control of plane screens and creation of items on their basis;

— preparation for and organization of production;

— development of technologic and production equipment;

— metrologic certification of testing of screen production.

Times and Volumes

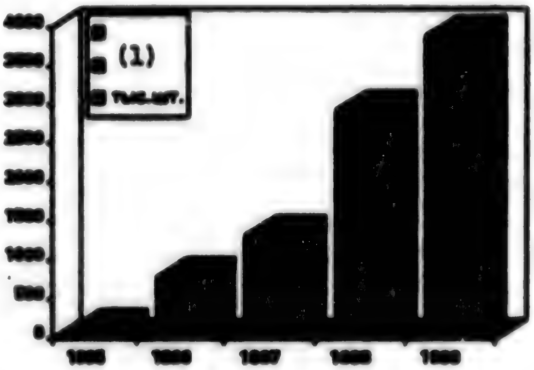
1. A standard line of passive matrix liquid crystal screens (PMLCS) of 100,000 units per year (Platan Scientific Research Institute and Volga Scientific Research Institute) — 1995.

2. Pilot lines of AMLCS of 40,000 units a year (Platan Scientific Research Institute — 1995, Volga Scientific Research Institute, Microelectronics Scientific Research Institute — 1996. Standard production plant of AMLCS of 500,000 units a year (Platan Scientific Research Institute) 1998.

3. Pilot line of gas-discharge (GDS) screens of 5,000 units a year (NIIGRP). Standard production plant for GDS — 100,000 units per year (NIIGRP).

4. Line of screens with matrix cold cathodes — 10,000 units per year (Volga Scientific Research Institute — 1998 and Istok State Scientific Production Enterprise.

5. Line of microcircuits — 1995 (Mikron plant).



1. Thousands of Units

Funding

The implementation of the program will require investment during the period 1994-2000 in an amount 106.7 billion rubles in 1993 prices, including for funding of scientific research and design work — 60.8 billion rubles for the development of the scientific-technical and production base — 45.9 billion rubles.

Cost Recovery Period

If the stipulated volumes of production are met the investment for different screens will be recovered in two-three years with a profitability 25-30 percent.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Organization of Production of Flat TV Screens for Pocket Color TV Sets, Personal Computers and Special Use

Development of designs of screens for different purpose.

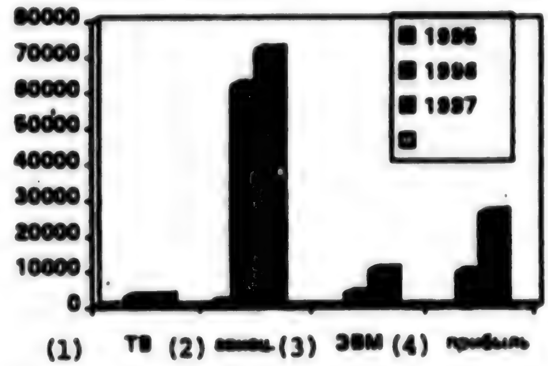
Work To Be Done Within Scope of Project

Development of production of liquid-crystal (LC) screens in two stages: in the first stage, construction of a pilot line in existing areas of the Platan Scientific Research Institute, in the second stage, after eliminating the bottlenecks, put the line into production with an output volume of 30,000-50,000 screens annually.

Development and fabrication of technologic and test equipment combining a precision similar to equipment for microelectronics with the possibility for processing large surfaces under especially pure conditions of the class "10"-"100."Development work has now been completed on the entire complex of the basic necessary equipment and a number of positions have been set up or are in a state of preparation.

Times and Volumes

Production can been initiated in 1995 with the planned volumes of sales and anticipated profit (millions or rubles) indicated in the bar graph.



1. TV 2. Aviation 3. Computers 4. Profit

Funding

Approximate amount of funding 9.5 billion rubles (3.5 million dollars) Form of funding — advantageous loan for 2.5 years.

Cost Recovery Period

The total recovery of the investment will be attained in 1966. The time of total repayment of the loan with interest will be in the first half of 1997.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Organization of Production of TV Sets With Flat Liquid-Crystal Screen

Development of light miniaturized TV equipment with excellent color characteristics, consuming considerably less power than those based on cathode-ray tubes, organization of their production with a volume of production 50,000 units per year.

They are used in built-in TVs of moving vehicles, TV cameras, monitors and automobile navigation systems.

Technical Specifications

Power — 8-10 W

Brightness — 100-150

Contrast — 50

Angle of view, degrees — 10-35

Number of elements — 288 x 480

Measurements — 140 x 100 x 35

Weight of TVs — 3.5-5 kg

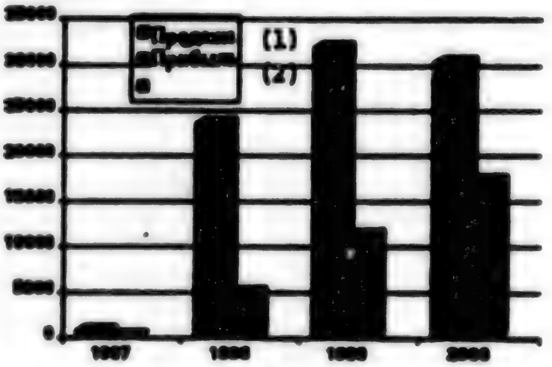
Controlling voltage — 12 V

Work To Be Done Within Scope of Project

Development of TV design Development of variety of special microcircuits for: control, radio channel, color module, video amplifier, power source, etc. Development of special full-color liquid-crystal screen. Development assembly line for boards for surface mounting. Development and fabrication of technologic gear. Acquisition of technologic and test equipment. Metrologic and certification testing. Organization of warranty servicing.

Times and Volumes

Production can be initiated in 1997 with the planned volumes of sales and anticipated profit (millions of rubles) indicated in the figure.



1. Sale 2. Profit

Funding

Approximate amount of funding 6 billion rubles (2 million dollars) Form of funding — advantageous loan for 5 years.

Cost Recovery Period

The total recovery of the investment will be attained in 1999.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Development and Organization of Production of Flat Information Screens With Matrix Autoemission Cathode

The basis of the project is the use of a matrix autoemission cathode for creating flat information screens used in portable TV sets, computers, aviation and automobile navigation systems, medical instruments and manufacture of a TV receiver.

Images are formed on the screen by low voltages (not more than 300 V), which precludes X radiation and makes the display or TV set ecologically clean. The use of cold autoemission cathodes instantaneous readiness when turned on.

Screens with a matrix autocathode are stable in a broad temperature range, are resistant to ionizing radiations, have a high characteristic luminescence (more than 300 Kd/m) and a high energy efficiency.

Technical Specifications

Principal parameters	Monochromatic screen	Full-color screen
Image size, mm (working diagonal)	100,160	160
Information capacity	288 x 468	288 x 156
Density of emission elements, cm	10^6	10^7
Image contrast	100/1	100/1

Principal parameters	Monochromatic screen	Full-color screen
Consumed power .W/dm	1	1
Number of brightness gradations	8	8

Work To Be Done Within Scope of Project

- applied research, optimization and planning of flat screens on a computer;
- development of technologic processes, special technologic equipment and organization of experimental production;
- development and manufacture of technologic support equipment;
- acquisition of special technologic equipment;
- creation of pilot lines for production of screens with productivity of 10-50 thousand units per year.

Times and Volumes

- Experimental copies of black-and-white screens with diagonals 10 and 16 cm — 1995-1997;
- standard production of 10,000 units per year — 1998;
- experimental copies of full-color screens for TV with a diagonal 16 cm — 1998;
- standard production — 2,500 units per year — 1999.

Fund and Cost Recovery Period

The approximate amount of necessary funding is 6 million dollars. The form of funding is an advantageous loan for 3-4 years.

If the stipulated volumes of production are met the recovery of the investment will be attained in 1998.

The time for full repayment of the loan with interest will be the first half of 1999.

Istok State Scientific Production Enterprise Volga Scientific Research Institute Physical Problems Scientific Research Institute Fax (095) 465-86-86

Project. Development and Organization of Production of Television Receivers With Flat Passive-Matrix Liquid-Crystal Screen (PMLCS)

The project provides for the development of TV receivers with fully adequate PMLCS.

The use of a liquid crystal (LC) screen instead of a cathode-ray tube will make it possible in the TV set to have: flat design, absence of electromagnetic and X radiations, substantially lesser weight and low consumed power.

TV receivers with PMLCS and special control microcircuits will in no way be inferior in quality (or almost not inferior) to television sets with AMLCS, differing from them in having a substantially simpler manufacture technology and cost.

Technical Specifications

As a result of the work done a small-series will be manufactured in the first stage, whereas in the second stage there will be mass production of TV sets with the following parameters:

- color television set with a screen diagonal 32 cm, thickness up to 5 cm and consumed power up to 30W.

Work To Be Done Within Scope of Project

- development of high-speed PLCS,
- development of set of complementary VLSI chips, realizing principle of active addressing principle and having a total integration level up to 50 million transistors,
- development of a wide range of necessary materials,
- development and acquisition of special technologic and metrologic equipment,
- preparation for and organization of production.

Times and Volumes

1995 — 1,000 units; 1996 — 10,000 units; 1997 — 50,000 units; 1998 — 300,000 units; 1999 — 500,000 units

Funding

first stage — 17 million dollars, second stage — 32 million dollars

Cost Recovery Period

first stage — 1998, second stage — 1999.

Volga Scientific Research Institute, Saratov Telefax (8452) 13-21-33

Project. Development and Standard Production of Large TV Screens Based on Gas-Discharge Indicator Panels (GDIP)

Development and organization of standard production of large color TV screens with 2.5- and 5-m diagonals.

Development and organization of standard production of flat color receivers with screen diagonals 51-84 cm.

The items are being produced on the basis of new-generation color gas-discharge indicator panels (GDIP) which are characterized by a high quality of the color image, absence of harmful radiations, presence of an internal memory and a broad temperature range allowing operation of display equipment on their basis outside rooms.

Under the first project large screens are being constructed on the modular principle, which will make it possible to make screens of virtually any area (up to 500 m^2. The screens are controlled by a personal computer and by all types of TV signals, ensuring reproduction of an enlarged (in comparison with the computer monitor) display image or large-format TV image. Provision is made for the availability of certificates of correspondence for safety, sanitary hygiene and electromagnetic compatibility with allowance for the requirements of the international ISO/IEC standards. The screens are competitive on domestic and foreign markets: projection screens, SID and LCI screens. The screens have no foreign equivalents and have certifiable cleanness for the Russian Federation, CIS countries and leading countries of the world.

The approximate need for the RF alone is up to 100 screens per year. The period for implementation of the first project is 1995-1996.

Under the second project flat color TV receivers will be produced on the basis of GDIP for a full number of imaging elements.

The new TV has the following new qualities and high consumer properties:

— flat design of TV (6-8 cm) with the possibility of its wall mounting;

— large size of screen exceeding the size of screens of known TVs based on flat liquid-crystal indicators (LCI);

— absence of geometric, nonlinear and color distortions;

— absence of image scintillations (due to GDIP internal memory;

— absence of X-ray, electromagnetic, infrared and ultraviolet radiations, which also will make it possible to use the TV as a display for personal computers and work stations.

Flat color TVs based on GDIP are being produced in Russia for the first time. The predicted annual need for such TVs in the Russian Federation is several hundred thousand.

The period for implementing the second project is 1995-1997.

Principal Technical Specifications

Items			
Name of Parameter (Characteristic)	Screen with 2.5-m Diagonal	Screen with 5-m Diagonal	Flat color TVs with 84-cm screen diagonal
1	2	3	4
Name	Display of TV and graphic information		Reception and Reproduction of Color TV Signal in PAL/SECAM/NTSC systems
Information capacity of pixels (RGB-triad)	640 x 512	640 x 480	768 x 576 (640 x 480)
Measurements of working field of screen, cm (inches)			
horizontal	200	400	67
vertical	160	300	50
diagonal	250 (100)	500 (200)	84 (33)
Number of modular GDIP in screen	10 x 8 (64 x 64 pixels)	20 x 15 (32 x 32 pixels)	
Reference white color of screen luminescence (color temperature) units X,Y,Z system	D6500 (x=0.313;y=0.329), 9300K (x=0.281;y=0.311)		D6500
Maximum luminescence in white light, kd/m^2	150-200	150-200	not less than 120
Contrast in large details	not less than 60:1	not less than 60:1	not less than 60:1
Watching distance, m	up to 25	up to 60	

Items			
Number of brightness levels	256	256	256
Averaged consumed power, W	1,500	5,500	150
Electric current	industrial net 50 Hz, 220 V	industrial net 50 Hz, 220 V	industrial net 50 Hz, 220 V
Weight	480	1,500	24
Average useful life, hours	30,000	30,000	30,000
Ambient temperature, °C	from -40 to +60	from -40 to +60	from -40 to +60

Funding and Cost Recovery Period

For the first project the required amount of investment will be 4 million dollars (with a production of up to 100 2.5- and 5-m screens). The cost recovery period will be 4 years.

For the second project the required amount of investment will be 12 million dollars (with an annual production of flat TVs of 50,000-100,000 units).

The costs for the project will be recovered in 3-4 years.

Plazma State Electronic Instruments Scientific Research Institute

Project. Development of New Types of Color Kinescopes, Deflecting Systems, Equipment and Materials for Them

- Development and organization of standard production of the most modern models of color TV kinescopes with ultrasmoothed corners, fattened screen in standard series 37, 45, 54, 61, 72.
- Color kinescopes of the indicated series have ergonomic and operational technical specifications, ensuring high image quality, reliability and longevity of items and in the shortest time possible must replace the produced old models of color kinescopes.
- The organization of standard production of new color kinescopes is the principal direction in implementation of the mentioned program and will ensure the competitiveness of Russian technology in the domestic market and a minimum in nearby foreign countries.

Technical Specifications

The series of new types of color kinescopes is characterized by the following principal parameters:

— changeover to ultrasmoothed and flattened screens of kinescopes up to a radius of screen curvature 1.4-1.7 R;

— replacement of optoelectronic systems (OES) with eccentricity = 6 mm, OES with eccentricity 5.08 mm, and also development of OES for throat of body 22.5 mm;

— use of highly efficient deflecting systems (DS) requiring reduced use of materials and lessened power consumption;

— decrease in residual nonreduction of rays over screen field to 1.0 mm - 1.5 mm;

— increase in operating reliability.

Work To Be Done Within Scope of Project

Development of new types of color kinescopes with the indicated technical specifications and putting them into standard production.

Putting into standard production of complementary materials for ensuring assembly work on kinescope production.

Fabrication of first models of large TV-frequency kinescopes. Times and Volumes

Year	New Models, Units	Total, Units
1994	150,000	4,100,000
1995	350,000	5,000,000
1996	800,000	5,500,000

Funding and Cost Recovery Period

In the prices of January 1993 the required funding is 58,283.0 million rubles and 259.0 million dollars.

With 25 percent profitability and a 50 percent deduction from the profit the recovery of expenditures will not require more than 1 1/2 years.

Moscow Electronics Plant Special Design Bureau, Moscow

Project. Basic Modules for Monochromatic and Color Kinescopes With Combined Design

The kinescopes are intended for the high-clarity display of TV and graphic information in multifunctional electronic service equipment. A color kinescope of this type has record ergonomic, electric and light engineering characteristics and makes it possible to create video monitors of the class U A, U A* and super A.

Technical Specifications

Size of working part of screen 325 x 243 mm; resolution 1,300 TV lines; screen brightness 80 kd/m; residual nonreduction, not more than 0.4 mm; contrast, not less than 150] antiglare, antistatic; L line = 240 μH.

The 45LKDTsS-0.26-0.28 kinescope will be developed and put into standard production within the scope of the project.

Times and Volumes

The following volumes of production are possible:

1995 — 10,000 units,

1996 — 100,000 units,

1997 — 250,000 units.

Funding

The necessary amount of funding is 27.0 billion rubles.

Cost Recovery Period

If the stipulated volume of production is met (with 25 percent profitability and 50 percent deduction from profit) the recovery of expenditures will not require more than 1 1/2 years.

Moscow Electronics Plant Special Design Bureau, Moscow Electronics Plant, Moscow

Project. Development and Introduction Into Standard Production of Video Projection System With Luminescent Screen for Individual (Household TV) and Group (Office, Auditorium, etc.) Use

The system is intended for displaying TV and graphic information on a luminescent screen with a diagonal 100-150 cm.

Technical Specifications

Screen brightness 120-180 kD/m2;

Resolution

RGB .... 1,200 TV lines.
video .... 900 TV lines.
Structural design — compact: 120 x 150 x 65 cm

Operating modes:

video .... PAL, SECAM
personal computer .... SGA, EGA, VGA
Consumed power — not more than 140 W.

Work To Be Done Within Scope of Project

Preparation of design documentation, manufacture of experimental consignment of projectors, development and fabrication of special equipment, preparations for standard production.

Times and Volumes

1997 — 1,000-3,000 units 1998 — 5,000=6,000 units 1999 — 10,000-12,000 units

Funding

The minimum amount of investment required is 200,000 dollars.

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The cost of similar items on the world market is 3,000-6,000 dollars.

The time for recovery of investments is 12-15 months from the time of commencement of production.

Moscow Electronics Plant Special Design Bureau, Moscow Electronics Plant, Moscow

Project. Airborne Color Electronic Instruments and Display Kinescopes for Civil Aviation

The airborne color kinescopes 25LKDTs-0.27, 16LKDTs-0.27, 47LKDTs-0.27 and 25LKDTs-index have high ergonomic and operational parameters in conformity to international aviation standards.

Technical Specifications

25LKDTsS: Measurements of working field 157 x 157 mm; flat filter, antiglare, antistatic, residual nonreduction 0.3 mm, resolution 600 TV lines, brightness 35 kd/m;

16LKDTsS: Measurements of working field 110 x 80 mm; resolution 450 TV lines; brightness 50 kd/m; residual nonreduction 0.3 mm, flat filter, antiglare, antistatic;

42LKDTsS: Resolution 1,100 TV lines; brightness 70 kd/m; residual nonreduction 0.3 mm, flat screen filter, antiglare, antistatic;

25LKDTsS-index: Measurements of working field 157 x 157 mm; brightness 500 kd/m; contrast 150; resolution 350 TV lines. All the items meet the requirements relative to external influencing factors.

Work To Be Done Within Scope of Project

- Development and completion of already initiated experimental design work with the above-mentioned principal technical specifications.
- Organization of standard production of airborne color electronic instruments fully ensuring the needs of clients.

Times and Volumes

The following volumes of production are possible when the enumerated work is accomplished:

	Type of Item	Total, Thousands of Units
1995	25LKDTsS-0.27	5.0
	42LKDTsS-0.24	2.0
1996	25LKDTsS-0.27	5.0
	42LKDTsS-0.24	3.0
	16LKDTsS-0.24	5.0
1997	25LKDTsS-0.27	5.0
	42LKDTsS-0.24	5.0
	16LKDTsS-0.24	5.0
	25LKDTsS-index	1.0

Funding

The necessary amount of funding is 3,980.0 million rubles

Cost Recovery Period

If the indicated volumes of funding are met (25 percent profitability and 50 percent deduction from profit) the recovery of expenditures will require no more than a year.

Moscow Electronics Plant Special Design Bureau, Moscow Electronics Plant

Project. Development of Laser TVF Projector Based on Laser Cathode-Ray Tube for Collective-Use Screens

The laser TVF (TV frequency) projector is intended for the display of full-color TV information from personal computers, video cameras, VCRs and other sources of TV signals on standard motion picture screens with an area up to 50 m^2. The laser TVF projector ensures a higher level of image quality in comparison with any other alternative systems for projection onto a large screen, which is ensured by use of quantoscopes — laser cathode-ray tubes — in the TVF projector. There is no foreign equivalent.

Technical Specifications

Output light flux, lumen — not less than 5.000 (in white light)

Resolution, TV lines, not less than 1,500

Image contrast — 1:100

Color contrast — 100 percent

Consumed power — up to 1 kW

Weight, kg — 300

Measurements, cm — 1,500 x 1,000 x 600

Work To Be Done Within Scope of Project

— development of technology for small-series production of new-generation quantoscopes

— development of technology for small-series production of radio engineering support

— conducting of design work

— acquisition of technologic and test equipment

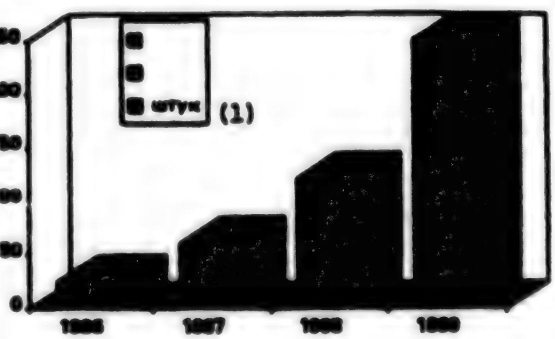
— preparations for and organization of production of TVF projector

— metrologic and certification testing

— organization of warranty servicing and training of users

Times and Volumes

The production of the laser TVF projector can be initiated in 1995 and increased by years: 1996 — 25 units 1997 — 60 units, 1998 — 120 units; 1999 — 250 units



1. Unit

Funding

The approximate amount of investment required is 850,000 dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest will be the second half of 1997.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Development and Startup of Production of Multifrequency Resolution Video Projector

The video projector is intended for the display of television and graphic information on a collective-use projection screen.

Technical Specifications

Image brightness, kd/m, not less than 200

Diagonal image brightness, 250 cm

Resolution, TV lines, 1,200

Operating modes: video (PAL, SECAM, NTSC), personal computer (VGA, SVGA)

Consumed power, VA, not more than 200

Work To Be Done Within Scope of Project

— working out of design documentation for series production

— development and fabrication of stands for adjusting and monitoring modules

— preparation for and organization of production

— certification tests

— organization of warranty and post-warranty servicing

Times and Volumes

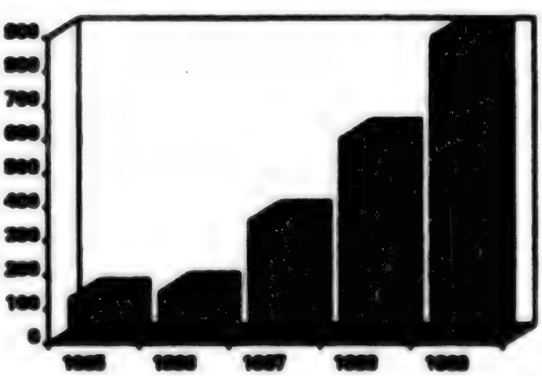
The production of the video projectors can be initiated in 1996 and will increase by years:

1996 — 150 units;

1997 — 360 units;

1998 — 600 units;

1999 — 900 units



Funding

The approximate amount of investment required is 360,000 dollars.

The form of funding is an advantageous load for 1.5 years.

Cost Recovery Period

If the indicated volumes of production are met the total recovery of the investment will be attained in the first half of 1996. The time of loan repayment will be the third quarter of 1996.

Platan Scientific Research Institute Scientific Research Plant Fax: 465-86-73, 921-27-55 for No 14

Project. Development and Startup of Production of Video Projection System With Doubled Light Flux

The video projection system is intended for large-screen display of advertising, television and graphic video information formed by different sources.

Technical Specifications

Light flux, lumen ... not less than 300 (mean value) Diagonal image measurement, cm ... up to 600 Video operating mode ... (PAL, SECAM) Personal computer ... (CGA, EGA, VGA) Power consumption, VA ... not more than 500

Work To Be Done Within Scope of Project

— development of design documentation for standard production

— development and fabrication of stands for adjusting and checking modules

— certification tests

— organization of warranty and post-warranty servicing

Times and Volumes:

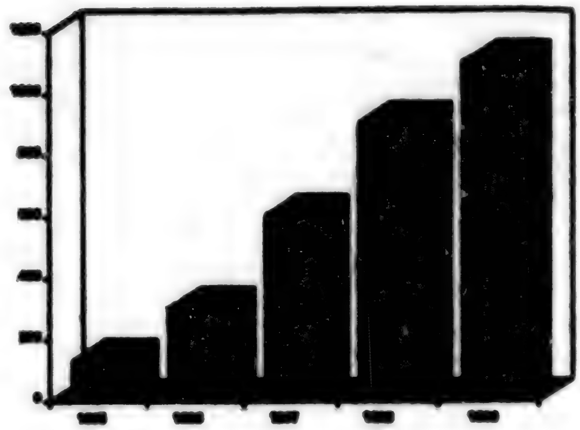
The production of video projectors can be initiated in 1996 and increased in accordance with market demand:

1996 — 300 units;

1997 — 600 units;

1998 — 900 units;

1999 — 1,100 units



Funding

Approximate amount of the necessary investment is 150,000 dollars.

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The cost of similar items on the world market is 30,000-60,000 dollars. The investment will be recovered a year after commencement of production of these items.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 931-27-55 for No 14

Project. Development of Projection-Type Monitor With Luminescent Screen and Its Introduction Into Production

The monitor is intended for display with an expansion 640 x 480, 800 x 600, 1,024 x 768, 2,048 x 1,024.

Technical Specifications

Image brightness, kd/m ... not less than 150

Iagonal measurement of image, cm ... 107

Expansion mode, IU ... up to 2,048 x 1,024

Automatic mode selection Consumed power, VA ... not more than 300

Work To Be Done Within Scope of Project

— preparation of design documentation for standard production

— development and fabrication of stands for adjusting and checking modules

— preparations for and organization of production

— certification tests

— organization of warranty and post-warranty servicing

Times and Volumes

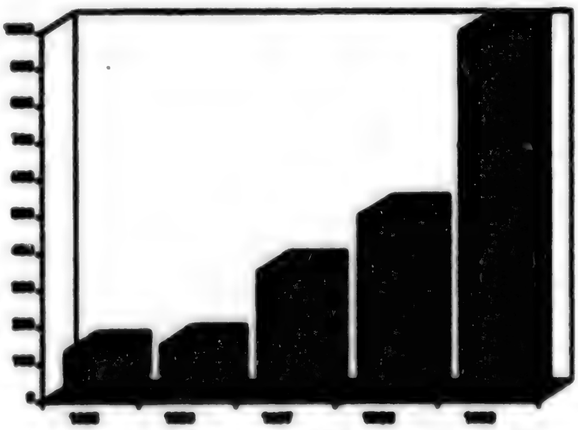
Production of the video projectors can be commenced in 1996 and increased in accordance with market requirements:

1996 — 150 units,

1997 — 350 units,

1998 — 500 units,

1999 — 1,000 units



Funding

The approximate amount of necessary investment is 750,000 dollars.

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The cost of similar items on the world market is 15,000-30,000 years.

Accordingly, the recovery of the investment can be attained a year after commencement of production of these items.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Developing Video Projector Based on Active Liquid Crystal Matrix and Putting It Into Production

The video projector is intended for the display of advertising, TV and graphic videoinformation formed by different sources on a large screen.

Active LC matrices developed and produced at the enterprise will be used in the video projector.

Technical Specifications

Light flux, lumen ... not less than 100 (mean value)

Diagonal measurement of image, cm ... up to 300

Operating mode: video (PAL, SECAM), personal computer (CGA, EGA, VGA)

Consumed power, VA ... not more than 500

Work To Be Done Within Scope of Project

— preparation of design documentation for standard production

— development and fabrication of stands for adjusting and checking modules

— preparations for and organization of production

— certification tests

— organization of warranty and post-warranty servicing

Times and Volumes

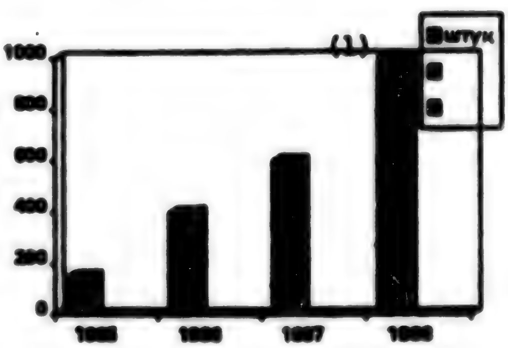
The production of video projectors can be initiated in 1996 and increased in accordance with market requirements.

1996 — 150 units,

1997 — 400 units,

1998 — 600 units,

1999 —1,000 units



1. Unit

Funding

The approximate amount of required investment is 950,000 dollars. The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The cost of similar items on the world market is 5,000-10,000 dollars.

Accordingly, the investment can be recovered 2 years after commencement of production of items.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Development of Technology for Large-Series Production of Antiglare Protective Filters for Personal Computer Monitors

The antiglare protective filter (APF) is intended for use when working with a monitor for the purpose of reducing the level of factors exerting a harmful effect on man.

Tests of the protective properties carried out in the accredited test laboratory of the Moscow Scientific Research Institute OKHRANA TRUDA, accredited test center TSIKLON-TEST, accredited scientific research center ERGONOMIKA SREDSTV OTOBRAZHENIYA and the Swedish Radiation Protection Institute have shown that the APF filters correspond to the best foreign analogues of the so-called TOTAL SHIELD type.

Technical Specifications

Electrostatic field attenuation factor — not less than 99 percent.

Attenuation factor of electric component of electromagnetic field in frequency range 20 Hz-100 Hz — 97-99 percent, in frequency range 20 Hz- 500 kHz — 80-96 percent.

Decrease in light glare level to 1-0.2 percent.

Full suppression of UV and X radiations.

Light transmission factor 30-70 percent.

Measurements 14"-21".

Work To Be Done Within Scope of Project

- development of a technology for large-series production;
- acquisition of technologic equipment;
- preparations for and organization of production;
- metrologic and certification testing

Times and Volumes

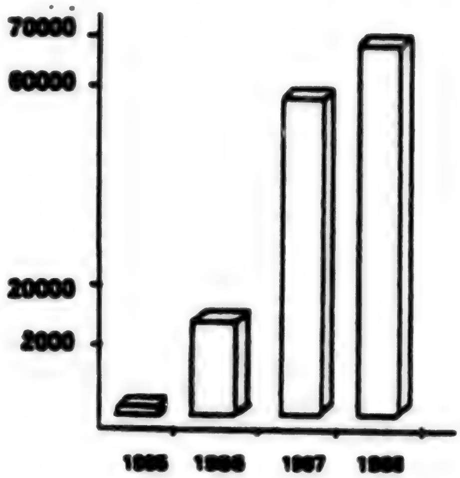
The large-series production of APF can be initiated in 1995.

1995 — 2,000 units/year;

1996 — 20,000 units/year;

1997 — 60,000 units/year;

1998 —70,000 units/year



Funding

The approximate amount of investment required is 2 million dollars.

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the planned volumes of production are met the investment will be recovered in 1996.

The time for full repayment of the loan with interest is 1997.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Project. Development, Manufacture of Experimental Consignment and Organization of Production of X-Ray-Television Complex Based on High- Resolution X-ray Vidicons

The X-ray television complex (XRTC) is intended for use in medicine for the diagnosis of different diseases. At the same time XRTC will find broad application in industry (in particular, for defectoscopy).

The XRTC have provision for coupling with a computer and accordingly, analysis and output of a research-observation program.

Technical Specifications

Spectral region of response — X-ray range

Contrast sensitivity — not more than 0.5 percent

Diameter of working field of target — 90 mm, 150 mm, 230 mm

Resolution — 6, 7 lines/mm

Operating modes: continuous, one-time, accumulative.

Screen — described or inscribed

Work To Be Done Within Scope of Project

— drawing up of design documentation for standard production

— development of technological stands and peripheral devices

— development of technology for production of X-ray vidicons

— preparation for and organization of production

— certification tests

— organization of warranty and post-warranty servicing

Times and Volumes

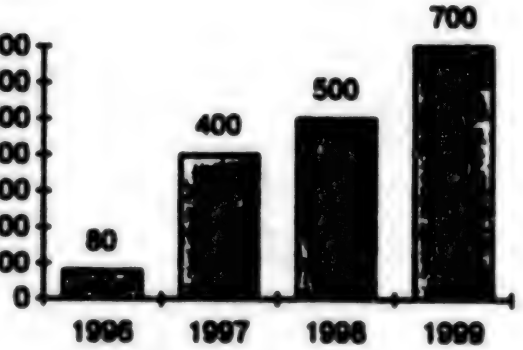
The production of XRTC can be initiated in 1996 and will increase by years:

1996 — 80 units;

1997 — 400 units;

1998 — 500 units;

1999 — 700 units.



Funding

The approximate amount of investment is 250,000 dollars. The form of funding is an advantageous credit for 2 years.

Cost Recovery Period

The investment will be recovered in 1997. The time for total repayment of the loan is 1997.

Platan Scientific Research Institute Scientific Research Institute plant Fax: 465-86-73, 921-27-55 for No 14

Photoelectronics During 1995-1997

R. M. Stepanov, Doctor of Technical Sciences, Professor

The increase in the production of photosensitive devices predicted for the next few years, ensuring electronic vision, in particular, of transmitting TV instruments in the IR, visible, UV and X-ray spectral ranges requires the development of new technologies, materials and equipment for their production.

The further development of photoelectronics affords additional possibilities for the use of optoelectronic and TV systems will ensure improvement of the information servicing of the infrastructure and rise to a new, higher level of TV broadcasting, ecologic monitoring, medical equipment, space research, banking, fax communication, home TV, monitoring and control in power production, etc.

The development of new generations of photoelectronic instruments having a sensitivity in the spectral ranges beyond the limits of human vision, increase in the resolution of instruments and their speed will considerably broaden the field of applicability of electronic vision systems in the economy. In addition to developing high-clarity TV broadcasting equipment it is desirable to make broader use of TV methods in ecology, criminalistics, polygraphy, cinematography and motion picture recording, cartography and systems for observation, detection, tracking and assault purposes.

In the ecology field the use of new transmitting TV instruments operating in the IR and UV ranges will make possible not only routine detection of gas leaks in major gas pipelines and thereby prevent large accidents, but also determination of contaminated areas of water surfaces by inorganic compounds. The use of these instruments in geologic prospecting will make it possible to study mineral deposits with an accuracy 3 to 5 times higher than existing methods ensure. The use of the new instruments in public health will make possible a decrease in the irradiation dose acting on man during roentgenoscopy by a factor of 5 and increase by a factor of 2-3 the reliability of TV information obtained in an endoscopic examination of man's internal organs.

The routine checking of the technical state of power equipment by use of IR instruments using IR instruments will make possible a twofold increase in the stability of operation of power stations and power transmission lines. An increase in the resolution of TV transmitting instruments and broadening of the spectral range of their response is giving rise to premises for increasing by a factor of 3-4 the amount of information obtained from space from stations of the Mir type and will make possible solution of the problem of transmitting TV images from solar system planets.

The development of highly sensitive TV instruments for the protection of objects will lighten the burden of

the work of personnel of the Ministry of Internal Affairs, will double the observation range and accordingly increase the probability of detection and identification of outsiders in the protected zone. The development of dactyloscopes using photosensitive solid-state matrices with charge transfer virtually cuts off the banking network against penetration by unauthorized individuals. All this is by far from a complete list of the material advantages and conveniences which are appearing as a result of the introduction of transmitting TV instruments in different economic fields.

In the industrially well-developed countries the development of photoelectronic instruments has become a priority development direction within the scope of state programs. For example, during the period up to 1993 Japan has spent more than 1 billion dollars, the United States more than 500 million dollars and the European Economic Community more than 800 million dollars on the development of high-clarity color TV systems.

The state program for the development of electronic technology is a component part of a unified program providing for the multisided development of photoelectronics during 1995-1997.

The principal participants in the program are the Elektron Central Scientific Research Institute, Pulsar Scientific Research Institute, Vostok Scientific Research Institute, NIIMET, NIIMV and SNIIM. The coparticipants are the Physical Technical Institute, A. F. Ioffe Russian Academy of Sciences (RAS), Physical Problems Scientific Research Institute, Siberian Department RAS, Giredmet, Association for Business Cooperation in the Photoelectronics Field, St. Petersburg Technical University and St. Petersburg Electrotechnical University.

The attainment of a competitive level of parameters is planned in the course of conducting development work on new photosensitive instruments. For example, for gleticons for high-clarity color TV systems by 1996-1997 plans call for obtaining instruments with a diameter 26, 18 and 13 mm with a 40 percent modulation in 800 lines. The response of a pyrovidicon with a DTGS target by this time will be increased to 35 μA/W. Using photomultipliers of the quantacon type the response at a wavelength of 840 nm will attain 50 mA/w. At the same time a photomultiplier with a translucent photocathode and intervalley electron transfer (TPCIVET) will be developed for the spectral region 0.9-1.6 μ with a response of about 0.1 μA/W, as well as a photomultiplier whose response limit will be 170 nm.

Uncooled matrix PCCD with frame transfer with a number of elements 1,920 x 1,152 elements will be developed by 1997. The number of elements of linear PCCD by that time will be increased to 2,048 or more. The response threshold of PCCD will be considerably increased. For example, by mid-1996 plans call for the completion of special design work on development of a hybrid instrument on the basis of an inversion image converter and a CCD matrix with a number of resolution elements 780 x 580, operating with an illumination 10^{-5} lux.

Development work will be completed by mid-1995 on a projection kinescope for 1,200 TV lines with an illuminance 25,000 kd/m^2 in the green, 13,000 kd/m^2 in the red and 3,000 kd/m^2 in the blue field for the reproduction of high-clarity TV images on a screen of increased size.

The most important technologic work is a technology for the formation of multilayer signaling plates with a transmission not less than 85 percent for HF TV vidicons by the method of high-frequency magnetron spraying with automatic control of parameters an development of a technology for the formation of sorption coding light filters with a planar technology for matrix PCCD which will be used in the production of photoelectronic instruments for color video cameras of the portable type (for journalistic and everyday purposes).

There are a number of projects providing for the development of electronic equipment based on new photoelectronic instruments. Their manufacture will ensure a stable profit with recovery of costs within 1 to 3 years (for individual types of items). For example, the development of a monoblock of three solid-state photosensitive matrices for a portable TV camera of the journalistic or household (for example, in a camcorder) type on the basis of a TV broadcasting standard existing at a given time, as well on the basis of a high-quality TV standard already during the first year of production promises a profit of about 30 percent on the investment. A higher profit up to 40 percent may be obtained from thermal imaging systems for medical examination of the population.

Investments Required for 1995-1997

No	Item of expenditures	Amount of expenditures by subprograms of photoelectronic instruments, millions of rubles					
		Instruments operating at low illumination level	Instruments for high-clarity color TV	IR instruments	UV instruments and photo-multipliers	Microchannel plates	Total
1.	Designing of instruments	7,895	7,448	25,478	3,950	1,200	45,971
2.	Development of technology, materials	575	1,472.5	4,732+2,000 (microcircuits)	650	400	9,829.5
3.	Development of technology and control-testing equipment	900	1,306	2,986	1,925	3,200	10,317
4.	Capital investments and reconstruction	3,200	4,700	13,500	1,200		22,600
	Total	12,570	14,926.5	48,696	7,725		88,717.5
	Cost recovery period	2.5	2.5	2.5	2	-	-

Volume of Production of Photoelectronic Instruments During 1995-1997

No	Name	Volume of production in 1995-1997 by subprograms, thousands of units/billions of rubles					
		Instruments operating at low illumination level	Instruments for high-clarity TV	IR instruments	UV instruments and photo-multipliers	Microchan-nel plates	Total
1	Safe movement of vehicles	40/40	-	18/30	25/20	10/12	93/102
2	Safe landing of aircraft	5/6	-	2.5/3	2.5/3	2.5/3	12.5/15
3	Safeguarding of objects	75/90	-	25/30	50/60	50/60	200/240
4	Guarding of boundaries	20/24	-	20/24	10/12	10/12	60/72
5	Ecologic monitoring	100/100	-	22/40	100/100	100/100	322/340
6	Vidicon studio cameras	-	10/18	-	-	-	10/13
7	Vidicon LCT	-	15/20	-	-	-	15/20
8	Vidicon CCD matrices	-	20/30	-	-	-	20/30
9	Control of power systems	-	-	1.2/10	2.5/3	-	3.7/13
10	Medical equipment	-	-	10/118.8	25/30	-	35/148.8
11	Fighting fires	-	-	13/25	-	-	13/25
Total	240/260	45/63	111.7/288.8	215/228	172.5/187	784.2/1,018.8	

Development of Equipment Using New Photoelectronic Instruments

No	Name of investment project	Implementation costs		Year of onset of production	Annual production, units	Annual profit, millions of rubles	Cost recovery period, years
		Total, millions of rubles	1995, millions of rubles				
1	Monoblock of 3 solid-state photoelectric converters for high-clarity TV system	1,860	500	1.996	330	745	2.5
2	TV camera for power systems	270	120	1,995	100	100	2.7
3	Solar cells based on amorphous silicon	1,950	500	1,997	5×10^6	500	3.0
4	Night vision systems and highly sensitive TV camera	840	540	1,996	11,000	900	1.0
5	TV system for hospital examination of population and environmental monitoring	570	190	1,995	75	225	3.0
6	UV system for histologic and biologic studies, defectoscopy and checking	240	56	1,996	200	280	1.0
7	Multilevel security systems	420	145	1,996	300	540	1.0
8	Ecologic and dosimetric measuring devices	500	196	1,996	2,000	300	1.5
9	TV equipment for counting formula blood elements	310	70	1,997	60	100	3.0
	Total	6,510	2,317	-	-	3690	

Image Converters for Night Vision Instruments

V. P. Beguchev, Candidate of Technical Sciences

Image converters constitute the basis for night vision instruments which make it possible to see under conditions of reduced illumination (from twilight to a moonless night) and are widely used in both military and civilian instrument making.

The successive development of four generations of image converters made it possible to develop four generations of night vision instruments (NVI) corresponding to the most diverse requirements of users.

In military technology NVI based on image converters brought about a revolution ensuring the possibility of conducting combat operations around the clock. The use of NVI together with TVs in recent military conflicts gave a substantial advantage to the forces using this technology.

Whereas before the 1980's image converters and NVI were used for the most part for special purposes,

recently they have more and more entered the civilian market and are finding wide application in scientific research and medicine, are used for nighttime hunting, for underwater work, for providing security for different objects, for nighttime guidance of vehicles, etc.

The Russian vacuum photoelectronics branch is now capable of ensuring the development and production of all generations of image converters, which puts it in the same ranks with the leading countries in this branch having similar capabilities (United States, Great Britain, France, West Germany, Netherlands).

Image converters of the zero generation constitute a glass vacuum flask with flat end surfaces (windows).

A photocathode fabricated using special technologic equipment on the inner side of the entrance window in a vacuum no poorer than 1×10^{-6} mm Hg. The emitted electrons are accelerated and are focused using a very simple inverter (inverting) optoelectronic system on a cathode-luminescent screen situated near the exit window or directly onto its surface.

Oxygen-antimony-cesium photocathodes (in the foreign classification S-1) have been used in such image converters.

The high level of development work and the production of one of the zero-generation image converters made it possible to develop a highly efficient sight for the most modern Russian tanks. Despite the known fundamental shortcomings of zero-generation image converters, the simplicity of their designs, absence of costly components and level of technologic perfection result in their low price and competitiveness on the market up to the present time. During recent years the demand for some types of image converters has increased due to the broadening of the production of simple and inexpensive NVI as consumer goods.

A fundamental fact concerning the development of the first generation of image converters was the use of fiber optic plates (FOP) in them.

The NVI created on the basis of first-generation NVI, due to more uniform field resolution, built-in power source, and also use in NVI of lighter mirror-lens objectives, have substantial advantages over NVI based on zero-generation image converters due to a higher image, lesser dimensions and weight.

First-generation NVI are finding use in the solution of nighttime vision problems in which the effective range is decisive and the GVKh have secondary importance portable observation NVI mounted on a tripod; transported NVI in tanks and mobile reconnaissance points; sights for antitank guns. At the same time first-generation NVI with image converters with a diameter 18 mm also are used as sights for light sharpshooting weapons.

The Moscow MELZ (Moscow Electronics Plant) at the present time has broad capabilities for the production of first-generation image converters in different variants for special and civilian NVI.

Second-generation image converters constructed abroad and in Russia have embodied the principle of microchannel amplification of the electron flux.

Second-generation image converters are now the main basis for manufacturing such NVI as binoculars, nighttime telescopes, sights for light sharpshooting weapons and some driving instruments. Which with an optimum entrance optical system ensure a visibility up to 300-500 m.

The Moscow MELZ plant, with the participation of the Electronics Instruments Scientific Research Institute, is now capable of producing second-generation image converter with a working diameter 25 mm at the level of the best foreign analogues (Varo 3063) in quantities up to thousands of units annually and if there are large orders is ready in a short time to undertake the production of image converters of the same generation with a working diameter 18 mm with parameters at the level of the best foreign second-generation image converters (Philips XX1500).

Further progress in image converter technology and the development of equipment for the fabrication and assembly of image converters in a deep vacuum, including "vacuum manipulators," made it possible to produce a flat (biplanar) image converter design. Due to the miniaturized design, as well as due to the use of more highly sensitive multislit photocathodes (S-25ERMA) in them they have been called image converters of the generation 2+.

Image converters of the generation 2+ for the first time made it possible to develop on their basis nighttime vision glasses with a weight not greater than 500-700 g. The nighttime glasses have a fundamental advantage over other NVI: fastened on the observer's head or on his helmet, they leave the hands free for necessary actions. Nighttime glasses can be used effectively in combination with a laser target indicator mounted on a weapon and adjusted with its aiming axis. The laser emits at a wavelength invisible to the eye and the aiming spot is observed only through the night vision glasses. The bullet hits the target at which the laser aiming spot is pointed.

In some designs of night glasses there is a laser emitter built into the housing (also with a wavelength invisible

to the eye) which is used in performing work in the total darkness (in a tunnel, in a shaft).

The Katod Special Design Bureau (Novosibirsk) has mastered the production of individual consignments of lighter-weight image converters of the generation 2^+, differing from known Western analogues by the absence of VOP at the input and output.

The MELZ plant, together with the Central Scientific Research Institute of Electronic instruments, is completing preparations for the standard production of image converters of the generation 2^+fully corresponding with respect to parameters and size to the well-known foreign analogue Litton M801.

The third-generation image converter incorporates all the advantages not only of vacuum electronics, but also semiconductor technology. The latter have made it possible to develop a highly efficient photocathode on the basis of semiconductor structures of $A^{III}B^{V}$ compounds with an active gallium arsenide layer.

The design of the third-generation image converters is similar to the design of an image converter of the generation 2^+ (other than the photocathode), but the technology is much more complex because it must ensure not only the fabrication of the photocathode and the assembly of the image converter in an ultrahigh vacuum (no poorer than 10^{-10} mm Hg), but also guarantee the maintenance of this vacuum in the image converter during its entire useful life. Even when using multiposition outfits for final assembly, making it possible to perform processing of several image converters at the same time, due to the prolonged and complex cycle for their fabrication, as well as the high cost of their components, the cost and price of such image converters turns out to be quite high.

The Electronics Instruments Scientific Research Institute and the Special Design Bureau of the Ekran plant have accomplished production of individual copies and small consignments of third-generation image converters, but the organization of large-scale production of such third-generation image converters requires serious investments. The well-known American ITT corporation, being the largest producer of third-generation image converters, has invested in the organization of their production (in addition to development work) more than 30 million dollars, but even with such investments the price of a third-generation image converter is not less than 2,500-3,000 dollars.

The development of third-generation image converters is not restricting the further development of image converters, which will occur in the following principal directions:

- broadening of the spectral characteristic of image converter photocathodes into the IR (to the thermal range) and UV spectral ranges;
- creation of image converters coupled to a CCD matrix, a "nighttime electronic eye" system with image processing and documentation using an electronic channel;
- creation of a completely solid-state image converter, using the "superlattices" and output emissive LED matrix for amplification.

Project. Image Converter of Generation 2^+ and 2^+ Super

Development and organization of standard production of image converters with direct transfer of electrons (planar type), with a multislit photocathode, electroluminescent screen on a fiber optic plate with a flat or spherical output, or by rotation of the image by 180°, with a built-in power source. The image converter is intended for amplification of image brightness in night vision instruments and low-level TV systems with different fields of application.

Technical Specifications

Response

integral — 350-500 μA/lumen (reference)

at wavelength 850 nm — not less than 22 mA/W

Conversion factor not less than 1,500

Resolution limit — not less than 32 lines/mm

Power voltage — constant 2.5 V

Consumed current — not more than 25 mA

Dimensions

external diameter — not more than 43 mm

length — not more than 42 mm

(worked out) — not more than 27 mm

Work To Be Done Within Scope of Project

- Preparation of design and technologic documentation for standard production.
- Development and fabrication of special technologic, control-measuring and test equipment.
- Conducting adjustment series with full cycle of tests in accordance with technical conditions.
- Organization of production of constituent elements (microchannel and fiber optic plates, electronic radio components for built-in power sources, etc.).

Times and Volumes

The production of image converters of the generation 2+ and 2+ super can be initiated in 1996 in accordance with market requirements: 1996 — 4,000 units; 1997 — 8,000 units; 1998 — 10,000 units; 1999 — 14,000 units

Funding

The approximate amount of investment required for implementing the work program will be 7 million dollars.

Form of funding — investment or advantageous loan for 3 years.

Cost Recovery Period

The cost of similar items on the world market is 2,000-2,500 dollars. The investment can be recovered 2.5 years after commencement of image converter production.

Moscow Electric Lamp Plant, Moscow For telegrams 111537, ION Fax: (095) 963-67-18.

Project. Universal Night Vision Glasses

Development and organization of production of an individual night vision instrument (NVI) of the type worn on the head.

The NVI is intended for orientation in the terrain, conducting engineering work, safety, etc. under conditions of natural nighttime illumination (moonless, starry, autumn sky), as well as in unlit rooms (cellars, attics, underground communication lines) with a brightening mode by a built-in light-emitting diode. In combination with a laser IR target finder the NVI can be used as a targeting device.

The NVI is being developed on the basis of a small image converter with an MKP produced by the enterprise.

Technical Specifications

Magnification, x — 1

Field of view, degrees — 40

Weight, kg — 0.5-0.6

Effective range for human figure, m — 150

Work to Be Done Within Scope of Project

- Drawing up of the design documentation for standard production.
- Organization of standard production.
- Certification tests.
- Organization of warranty and post-warranty servicing.

Times and Volumes

The production of these NVI can be initiated in 1996 and increased in accordance with market demand:

1996 — 150 units,

1997 — 200 units,

1998 — 500 units,

1999 — 1,000 units.

Funding

The approximate amount of necessary investment is 500,000 dollars.

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

The cost of a similar item on the world market is 12,800 dollars.

The cost of the proposed instrument is 2,300 dollars.

The investment can be paid off three years after commencement of production of the items.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION. Fax: (095) 306-02-49.

Project. "Electronic Eye" TV Camera

Development and organization of production of a low-level TV camera based on an image converter with a CCD matrix. The "electronic eye" camera is intended for observing objects in the range of illuminations 5 x 10^{-5} - 1,000 lux. Fields of application: military equipment, observation systems, robot technology, scientific research.

The TV camera will use an image converter with an MKP, coupled to a CCD, developed by the enterprise.

Technical Specifications

Resolution with illumination 10^{-4} lux — 350 TV lines

Range of illuminations — 5 x 10^{-5} - 1,000 lux

Power voltage — 12 V

Consumed power — 5 W

Weight (without objective) — 1.5 kg

Work to Be Done Within Scope of Project

- Preparation of "electronic eye" design.
- Fabrication and testing of experimental copies.
- Preparations for production.

Times and Volumes

The production of the "electronic eye" can be initiated in 1995 and increased in accordance with market demand:

1996 — 200 units,

1997 — 500 units,

1998 — 1,000 units,

1999 — 1,000 units.

Funding

Approximate investment amount — 125,000 dollars.

Form of funding — advantageous loan for 2 years.

Time of recovery of investment — 1 year from commencement of production.

Electronic Instruments Scientific Research Institute, Moscow. For telegrams: 111537 ION. Fax: (095) 306-02-49.

Project. Camera for Remote Monitoring of Radiation Contamination of Terrain

The development and organization of production of the camera on the basis of a specially developed Russian inverter image converter with multichannel amplification, sensitive in the UV spectral region (entrance window of MgF_2, fiber optic plate, built-in power source); the image converter is coupled to a CCD matrix.

The TV system ensures registry of data on a video tape recorder and computer.

The camera is intended for the detection of terrain sectors with an increased radiation background and evaluation of the radiation contamination level.

Technical Specifications

Spectral range of registered radiation, nm — 200-400

Quantum efficiency at wavelengths

220-250 nm, percent — not less than 10

Resolution, TV lines — not less than 400

Work to Be Done Within Scope of Project

- Development of design and technology of camera fabrication.
- Software development.
- Fabrication of experimental copy and conducting of tests.

Times and Volumes

Camera production can be initiated in 1996 and will be increased in accordance with market requirements:

1996 — 50 units;

1997 — 50 units;

1998 — 50 units;

1999 — 100 units.

Funding

The approximate amount of the required investment is 200,000 dollars.

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

The cost of such an item on the world market is 18,000-20,000 dollars (there are no other instruments of exactly the same type).

The recovery of the investment is possible 3 years after commencement of instrument production.

Project. Infrared Microscope

Development and organization of standard production of an IR microscope for determining authenticity of valuable papers and documents.

The microscope is intended for visual examination of objects in direct and in reflected IR light. The instrument can be used in criminalistics and banking for detecting traces of erasures and corrections, including in places with spilled ink, etc., as well as for checking the quality of electronic equipment items during their production.

The IR microscope is developed on the basis of an image converter with a special photocathode developed and produced by the enterprise.

Technical Specifications

Working field, mm — 23

Optical magnification, x — 100

Resolution, lines/mm — 50

Work To Be Done Within Scope of Project

- Preparation of design documentation for IR microscope.
- Fabrication of experimental copies and testing.
- Organization of warranty and post-warranty servicing.

Times and Volumes

Standard production can be initiated beginning in 1996 in a volume 100-200 instruments annually in accordance with market demand.

Funding

The approximate amount of necessary investment is 100,000 dollars.

Form of funding — advantageous loan for 2 years.

Cost Recovery Period

The cost of similar microscopes produced by the LOMO (Leningrad Optical Mechanical Association) (inferior to that proposed for development with respect to size of working field and resolution) is 6,000-7,000 dollars.

The time required for recovery of the investment will be 3 years after commencement of production.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION Telephone: (095) 176-17-09. Fax: (095) 306-02-49.

Project. Plane X-Ray Image Brightness Amplifier

Organization of the standard production of a plane X-ray image amplifier (XRIA) for medical X-ray diagnostic equipment based on a plane X-ray image converter (XRIC).

A plane XRIA ensures a substantial increase in the information yield of the X-ray image, reduces the irradiation dose received by the patient and roentgenologist by a factor of 2-3, allows research to be conducted in a slightly darkened room and is intended for installation on any type of medical X-ray diagnostic equipment in place of a fluorescent screen. A plane XRIA uses a specially developed plane XRIC ensuring direct observation of the X-ray image on the XRIC screen.

Technical Specifications

Diameter of working field at input and output — 220 mm

Factor for conversion from X-radiation to visible radiation — 1.5 (kd/m^2)/mR/s)

Resolution — 1.8 pairs of lines/mm

Image contrast — 0.93 (15:1)

Work To Be Done Within Scope of Project

- Organization of standard production of plane XRIC and accessories for it;
- Organization of standard production of plane XRIA;
- Organization of warranty and post-warranty servicing.

Times and Volumes

Production of plane XRIA can be initiated in 1995 and increased as market demand increases:

1995 — 300 units,

1996 — 500 units,

1997 —750 units,

1998 — 1,000 units.

Funding

An investment of approximately 150 million rubles (450,000 dollars) is required for organizing standard production and production of plane XRIA and XRIC.

Form of funding — advantageous loan for 1.5 years.

Cost Recovery Period

The cost of Russian TV XRIA is 25-30 million rubles per unit (10,000 dollars), the cost of imported units is 35,000 dollars.

The cost of the plane XRIA proposed for production is not more than 10 million rubles per unit (3,000 dollars).

Plane XRIA are not produced abroad.

Recovery of the investment cost is possible 1 year after commencement of XRIA production.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION. Fax: (095) 306-02-49.

Project. X-Ray Image Brightness Amplifiers

Development and organization of standard production of a TV X-ray image amplifier (TV XRIA) for medical X-ray diagnostic equipment and an X-ray image converter (XRIC) with an electrostatic transforming electronic lens for it.

The TV XRIA is installed in X-ray diagnostic equipment. It ensures a decrease in the irradiation dose for the patient and roentgenologist by a factor of 15-20. The X-ray image is observed on a monitor screen.

The amplifier includes an XRIC specially developed by the enterprise. It has a high image contrast, electrostatic transforming lens, electronic change of image scale and cesium iodide input screen.

The TV XRIC consists of an XRIC in a housing with radiation and magnetic protection, power unit for the XRIC, optical system for transfer of the image onto a TV tube target, photoscanning device and closed TV system with a monitor.

Technical Specifications

Input working field (with electronic regulation of diameter)

large diameter — 230 mm

small diameter — 150 mm

Conversion factor: X-radiation into visible radiation

large field — 100 kd/m^2)/mR/s)

small field — 65 kd/m^2)/mR/s)

Resolution

large field — 2 pairs of lines/mm

small field — 3 pairs of lines/mm

Image contrast

large field — 0.95 (20:1)

small field — 0.95 (25:1)

Work To Be Done Within Scope of Project

- Completion of development work on TV XRIA, fabrication of experimental copies and their testing.
- Organization of standard production of TV XRIA, XRIC for TV XRIA, and production of assemblies, parts and accessories for them.

Times and Volumes

Production of the TV XRIA can be initiated beginning in 1995 and increased in accordance with market requirements:

1995 — 100 units,

1996 — 300 units,

1997 — 500 units,

1998 — 750 units.

Funding

Development work and the organization of standard production of the TV XRIA will require an approximate investment of 3,000 million rubles (900,000 dollars).

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The cost of imported TV XRIA is up to 35,000 dollars.

The cost of TV XRIA manufactured in Russia (with parameters lower than those proposed) is 300 million rubles (10,000 dollars).

The cost of the TV XRIA proposed for development and production is not more than 24 million rubles (8,000 dollars).

The investment cost can be recovered 2 years after commencement of XRIA production.

Electronic Instruments Scientific Research Institute, Moscow Fax: (095) 306-02-49

Project. Gamma Camera for Diagnostic Purposes

Development and organization of production of a scintillation gamma camera with a large field of view (analogue of the GCA-601 camera produced by the Japanese Toshiba Company).

The scintillation gamma camera with a large field of view, based on hexahedral photomultipliers, is intended for early diagnosis of oncologic, cardiovascular and other diseases and functional disorders in vital functioning of human internal organs and physiological systems.

Technical Specifications

Diameter of useful field of view — 420 mm

Resolution — 5 mm

Voltage nonuniformity — +/-5 percent

Energy resolution — not more than 12 percent

Number of hexahedral photomultipliers — 37

Work To Be Done Within Scope of Project

- Preparation of design-technologic documents for standard production of gamma cameras and hexahedral photomultipliers.
- Preparations for production.
- Conducting clinical tests.

Times and Volumes

Production of the scintillation gamma camera with a large field of view can be initiated in 1997 and increased in accordance with market demand:

1997 — 2 units,

1998 — 18 units

1999 — 22 units,

2000 — 30 units.

Funding

The approximate amount of the necessary investment is 560 thousand dollars.

Form of funding — advantageous loan for 3 years.

Cost Recovery Period

The cost of the Japanese TOSHIBA GCA-601 gamma camera is 200 thousand dollars.

The investment cost can be recovered after production of the items has begun.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION Fax: (095) 306-02-49

Project. Tomographic Gamma Camera for Diagnostic Purposes

The organization of standard production of the GKS-301 tomographic gamma camera on the basis of an FEU-184 photomultiplier.

The tomographic gamma camera is a universal radiodiagnostic system ensuring the performance of all presently known radiodiagnostic methods directed to the early diagnosis of cardiovascular, oncologic and other socially very dangerous diseases of the population.

Development work on the gamma camera was completed in 1994; experimental copies were fabricated and tested.

Technical Specifications

Diameter of useful field of view — 390 mm

Resolution — 5 mm

Voltage nonuniformity — +/-5 percent

Energy resolution — not more than 12 percent

Number of photomultipliers — 75

Work To Be Done Within Scope of Project

- Preparation of design-technologic documents for GKS-301 tomographic gamma camera.
- Preparations for production.
- Conducting clinical tests.

Times and Volumes

Production of the GKS-301 tomographic gamma camera can be initiated in 1996 and will increase as the market increases:

1996 — 2 units,

1998 —22 units,

1997 — 18 units,

1999 — 30 units.

Funding

The approximate amount of the required investment is 230,000 dollars.

The form of funding is an advantageous loan for 1.5 years.

Cost Recovery Period

The cost of similar items on the world market is 300,000 dollars.

The time required for recovery of the investment may be 1.5 years after commencement of gamma camera production.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION Fax: (095) 306-02-49

Project. X-Ray Television Microscope

Development and organization of production of X-ray television microscope for checking grain crops and food products for contamination.

The microscope will make possible effective checking for contamination in a wide range of grain crops and food products in the laboratory, at custom houses and other places of their receipt, storage and sale.

The presence of a TV monitor and special peripheral devices will make it possible to carry out remote observation and documentation of the results of this checking (video taping, photography).

The microscope will use a special X-ray image converter developed and produced by the enterprise, coupled to a CCD matrix.

Technical Specifications

Diameter of working field, mm — 40

Resolution, lines/mm — 10

Range of X-radiation, keV — 10-100

X-ray magnification ... 10

Work To Be Done Within Scope of Project

- Preparation of design documentation for microscope.
- Fabrication and testing of experimental copies.
- Preparations for production.
- Organization of warranty and post-warranty servicing for the microscopes.

Times and Volumes

Standard production can be initiated in 1996 and increased as the market requires:

1996 — 50 units,

1997 — 100 units,

1998-2000 — 200-300 units annually.

Funding

The approximate amount of the required investment is 150,000 dollars.

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

The investment will be recovered 3 years after commencement of production. The approximate price of the X-ray television microscope is 5,000-7,000 dollars.

No similar types of equipment are known.

Electronic Instruments Scientific Research Institute, Moscow Telephone: (095) 176-17-09 Fax: (095) 306-02-49

Project. Low-Dose Medical Fluorograph

Development of a low-dose medical fluorograph and its introduction into standard production.

The fluorograph is intended for large-scale examinations of the population for the early diagnosis of tuberculosis, oncologic diseases, etc. The use of an image converter with an 80-mm field of view makes it possible to amplify the image and reduce the irradiation dose by a factor of more than 20.

An experimental copy of such a fluorograph was developed in 1993 in collaboration with the Zvenigorod Optomechanical Plant.

Technical Specifications

Measurements of working field — 360 x 360 mm

Dose on plane detector — 0.5 mR (less by a factor of 20 than for existing instruments)

Spatial resolution — 2.5 pairs of lines/mm

Contrast sensitivity — 2 percent

Work To Be Done Within Scope of Project

- Perfection and organization of production of unstructured fiber optic plates with working diameter of 90 mm.
- Putting image converters with a field of view not less than 85 mm into standard production.
- Putting low-dose fluorographic cameras into standard production.
- Putting low-dose fluorograph into standard production.

Times and Volumes

Fluorograph production can be initiated beginning in 1996 and increased in accordance with market needs:

1996 — 30 units,

1997 — 50 units,

1998 — 300 units.

Funding

The required investment is 900,000 dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

The cost of a similar item on the world market is 30,000-50,000 dollars; the cost of the developed item in the first two years of standard production is 20,000 dollars.

The period for recovery of the investment is 3 years.

Electronic Instruments Scientific Research Institute, Moscow For telegrams: 111537 ION Fax: (095) 306-02-49

Quantum Electronics. Prospects for Development

A. A. Kazakov, candidate of physical and mathematical sciences

Quantum electronics, broadly entering into science, production and the every-day life of people as a powerful means for creating fundamentally new technologies in all fields of human activity, represents an independent branch of electronics. Quantum electronics is concerned with the theory and practice of different devices whose operation is based on forced radiation and nonlinear interaction between radiation and matter. Among such devices, in addition to lasers of different types, there are amplifiers and devices for conversion of the frequency of electromagnetic radiation in the range from 0.2 μm to 10 μm, laser gyroscopes, frequency standards and parametric light generators. Modern lasers are used in virtually all fields of science, technology and the economy.

In Russia there are more than a hundred different research centers and producers of laser equipment, the largest of which belong to the electronics industry:

Polyus Scientific Research Institute (Moscow), specializing in the development of semiconductor and solid-state lasers, nonlinear optics, laser gyroscopes for systems for the control of motion, range finders and target

indicators, components for quantum electronics, laser technologies, materials and instruments for medicine;

Plazma Scientific Production Association (Ryazan) — the largest developer and manufacturer of gas lasers, emitting in a broad range of wavelengths from the UV to the IR;

Zenit Scientific Research Institute (Zelenograd) — the leader in the field of development and production of gas-discharge high-intensity light sources for the pumping of crystal solid-state lasers, as well as excimer lasers and dye lasers with tube pumping;

Istok Scientific Production Association (Fryazino), producing powerful gas lasers, medical and technologic equipment;

Volga Scientific Research Institute (Saratov), developing semiconductor lasers.

The largest producers of laser technology in the country are the Ulyanovo Radio Tube Plant, Kaluga Radio Tube Plant, Bogoroditskiy Plant for Technochemical Items, Sergach Electromechanical Plant, and others.

The Russian State Program for the Development of Electronic Equipment includes a number of directions in the quantum electronics field: basic and applied research in the field of creating fundamentally new devices and instruments; improvement and production of a new laser technology component base.

In the field of basic work this includes, in particular, research on new excitation and generation phenomena, search for new active media and nonlinear materials, creation of new technologies in the field of synthesis and processing of semiconductor structures and thin films. Practical use and broad introduction into laser technology of nonlinear optical devices — converters of optical frequencies, parametric lasers, wave front inversion devices and tunable optoacoustic filters — will ensure the creation of powerful, efficient lasers with unique radiation quality parameters in the entire spectral range.

In the field of solid-state lasers the principal direction in the work is the development and widespread industrial mastery of solid-state lasers with semiconductor pumping. A changeover from lasers with tube pumping with a broad and energetically inefficient emission spectrum to narrow-band highly efficient semiconductor lasers is revolutionizing solid-state laser technology.

The appearance of powerful lasers with semiconductor pumping and with an efficiency exceeding the efficiency of existing lasers by a factor of 8-10 is fundamentally changing traditional applications and will serve as a new stimulus in the development of technologies, implementation of scientific research and creation of military technology. In addition, solid-state tunable lasers and superpowerful lasers with an ultrashort duration of radiation are being constantly improved. For instruments in wide use, such as laser range finders, there will be a changeover to a radiation range safe for vision.

In the field of semiconductor lasers, work for the most part has been directed to the creation of powerful laser diodes and grids for the pumping of solid-state lasers, development of semiconductor structures in the visible, including blue-green radiation range and improving receiving-transmitting and amplification devices for fiber optic communication systems. A new type of lasers — fiber lasers based on active (doped) fibers with semiconductor pumping has been created and is being improved actively on the basis of advances in this field of quantum electronics.

Gas lasers occupy a large sector in the laser technology market; there are more than 100 models which are produced in different series. Among them are small stable helium-neon, ion, argon, krypton and helium-cadmium lasers, molecular — nitrogen and CO_2 lasers and excimer lasers operating in the short-wave radiation range. The further improvement of this class of instruments is going in the direction of a decrease in size, an increase in their reliability and efficiency and exploitation of new radiation ranges.

The State Program for the Development of Electronics Technology provides for ongoing improvement in the technology for obtaining laser technology materials, active and nonlinear materials, laser mirrors with ultralow losses and high-quality semiconductor structures.

Work is continuing on the further development of the design of laser gyroscopes for traditional applications in the aviation industry and for new applications in the mining industry, the drilling of boreholes and precise machine building. A qualitatively new component base for laser instrument making in technology, medicine, communication, scientific research and military technology will be created in the course of implementation of the program for the development of electronic equipment.

Project: New Radiation Sources

Development of technology and organization of production of instruments of a new class — small and efficient sources of powerful highly coherent radiation in wavelength ranges from 670 to 1,000 nm, including at wavelengths 670, 780, 810, 850, and 980 nm, on the basis of a combination of a single-frequency laser amplifier based on a single semiconductor crystal. The powerful laser-coherent amplifier (PLCA) is intended for broad

use in technology (surface cleaning, cutting, scrubbing, microwelding, etc.); in medicine (minor surgery, ophthalmology, photodynamic therapy, etc.); for pumping fiber, solid-state lasers and fiber optic amplifiers; for frequency doubling in nonlinear crystals for developing efficient and high-quality lasers operating in the blue-green region; as emitters in intersatellite communication line equipment; in high-resolution spectrometry, etc.

In comparison with existing radiation sources (laser diodes, solid-state, fiber and other lasers) PLCA in a single instrument combine high accuracy, high coherence, diffractive divergence, high efficiency, compactness, mechanical strength, uniformity of luminescent body and increased reliability.

Technical Specifications

Radiation wavelengths — 670, 780, 810, 850, 980 nm

Half-width of emission line — several MHz

High radiation power — 0.5-3 W

Density of output radiation — up to 10^6 W/cm^2

Approximate cost of instruments from 500 to 10,000 dollars, depending on set of parameters and degree of integration.

Work To Be Done Within Scope of Project

- Development of a laboratory technology and creation of designs of PLCA instruments for the indicated series of wavelengths and output power levels, as well as a different structural design (with fiber output, quasiparallel ray, with a focused optical system, etc.);
- Development of a technology for experimental and standard production, organization of production;
- Development, fabrication and acquisition of technological gear, technological and test equipment;
- Metrologic and certification testing.

Times and Volumes

Production of the PLCA can be initiated in the second half of 1995 and will increase annually:

1995 — 1,000 units;

1996 — 8,000 units;

1997 — 15,000 units;

1998 — 30,000 units.

The indicated figures are for PLCA instruments with an average price 1,500 dollars each.

Funding and Recovery of Costs

The approximate amount of investment necessary for implementing the work program is 8 million dollars. The form of funding is investment for two years. If the stipulated volume of production is met, the investment will be fully recovered in 1997.

Polyus Scientific Research Institute, Moscow Telephone: (095) 330-0365, 334-2038.

Project. Semiconductor Laser Diodes Operating in Blue and UV Radiation Ranges

Development of a technology for production of semiconductor laser diodes operating in the blue and UV radiation ranges (SPL-400) and organization of their standard production.

Laser diodes operating in the blue and UV ranges are intended for use in optical systems for the registry and readout of information, which will make possible a tenfold increase in the density of registry of the optical information on the media. The unique capabilities of lasers operating in the short-wave range may find application in laser therapy, luminescent diagnosis of biopreparations and in technological equipment for the production of microelectronics industry items.

Technical Specifications

Material of chip heterostructure in AlInGaN system Radiation wavelength — 300-450 nm

Working voltage — less than 8 V

Working current — less than 200 mA

Radiation power — 1-3 mW

Diameter of housing — 5.6 mm

Approximate price with standard production — 50 dollars

Work To Be Done Within Scope of Project

- Development of a technology for standard production of laser emitters, including production of gallium nitride monocrystals for substrates.
- Development of special technological equipment (epitaxy reactors, etc.) and organization of production of equipment and accessories.
- Organization of standard production of emitters.
- Metrologic and certification tests.

Times and Volumes

Production of the SPL-400 can be initiated in 1995 with a year-to-year increase (thousands of units):

1995 — 20;

1996 — 250;

1997 — 500.

Funding and Cost Recovery Period

The approximate amount of the necessary investment for implementing the work program is 12 million dollars. The form of funding is an advantageous loan for 2 years. The investment will be recovered after two years (late 1996). The time for full repayment of the loan with interest is the first half of 1997.

Polyus Scientific Research Institute, Moscow Telephone: (095) 330-03-65, 334-20-38

Project. Set of Measuring Navigational Systems Based on Annular Lasers for Conducting Underground Work

The outfit has a number of advantages with respect to accuracy, reliability and time of readiness for operation in comparison with known Russian and foreign instruments. The following will be developed and fabricated:

Clinometer for determining inclination and list of drill head in process of trenchless laying of pipelines;

Inclinometer for measuring trajectories of vertical, slant and horizontal boreholes and pipelines;

Borehole instrument for continuous measurement of directions of drilling of holes of a complex configuration.

Spatial orientation unit for measuring spatial position (azimuth, inclinations, distortion) and deflection of drill head from intended path.

Technical Specifications

Clinometer — error in determining inclinations and list 10"; dimensions: diameter 85 mm, length 900 mm, weight 18 kg.

Inclinometer — error in determining direction of hole axis 0.2°; dimensions: diameter 100 mm, length 1,300 mm, weight 25 kg.

Borehole instrument — accuracy in determining azimuth and inclination of drilling direction 0.2°; measurements: diameter 100 mm, length 1,500 mm, weight 28 kg.

Spatial orientation unit — error in determining spatial position of drill head: azimuth 0.8°, angles of inclination and tilt 20"; dimensions: diameter 140 mm, length 1,500 mm, weight 35 kg.

Work To Be Done Within Scope of Project

- Preparation of design and technological documents.
- Acquisition and fabrication of technological and test equipment.
- Preparations for and organization of production.
- Metrologic certification tests.
- Organization of warranty servicing and training of users.

Times and Volumes

1995 — 1 outfit,

1996 — 100 outfits,

1997 — 100 outfits.

Funding and Cost Recovery Period

The approximate amount of necessary investment for implementing the work program is 4 million dollars. The form of funding is an advantageous loan.

If the stipulated volumes of production are met, total recovery of the investment will be attained in late 1997. The time for full repayment of the loan with interest will be the first half of 1998.

Polyus Scientific Research Institute, Moscow

Project. Self-Contained Gyroscopic Navigation System

The system is intended for controlling the drilling for the penetrating shield when constructing tunnels on complex curvilinear paths, as well as in moisture-saturated ground, ground with a high dust content, under impacts and vibration. Interest in use of the system has been expressed by: Mosinzhstroy, Mosmetrostroy and Lenmetrostroy. The system also can be used as a construction gyrotheodolite.

Technical Specifications

Error in determining azimuth — 5 minutes of angle

Error in determining tilts and distortion — 0.1 minute of angle

Error in determining deflection axis of shield from intended alignment

in vertical plane — 20 mm

in horizontal plane — 45 mm

Measurements — 550 x 550 x 320 mm

Weight — 30 kg

Work To Be Done Within Scope of Project

- Development of a production technology.
- Preparation of rigging, acquisition of equipment.
- Preparation for and introduction of standard production.
- Organization of warranty servicing, training of work force.

Times and Volumes

Production of the GNS can be initiated beginning in the second half of 1995 with 10 units and then increases each year:

1995 — 10 units,

1996 — 50 units,

1997 — 200 units.

Funding and Cost Recovery Period

The amount of investment necessary for production work is 800,000 dollars. The form of funding is an advantageous credit. Cost recovery will be possible, assuming the proposed production rate, by mid-1997. Repayment of the loan, with interest, will be in late 1997.

Polyus Scientific Research Institute, Moscow

Modern Directions in Development of Piezotechnology

N. N. Kudryavtsev, doctor of physical and mathematical sciences, professor

One of the characteristic trends in the world electronics goods market in the early 1990's is the continuously increasing demand for all types of piezoelectronic devices for industrial and household use. This is attributable, on one hand, to a sharp increase in the production of computers, and on the other, to the vigorous development of a new generation of electronic equipment, its complex miniaturization and improvement in operating characteristics.

Relatively recently the piezoelectronic instruments industry, traditionally based on artificial quartz, has been afforded possibilities for the production of new instruments based on strong piezoelectrics: lithium niabate, tantalate and tetraborate, as well as berlinite and langasite. This qualitative jump in the piezoelectronics industry has led to a sharp broadening of the variety of virtually all items and has exerted a strong influence on improvement in the characteristics of electronic equipment and computers.

The Fonon Scientific Research Institute, organized in 1944, is the leading enterprise for research and development work on different kinds of piezotechnical devices based on three-dimensional acoustic waves (TDAW) and surface acoustic waves (SAW).

The products developed by the institute and the copies of its items are widely used in modern types of electronic equipment: space navigation and communication, rocket technology, measuring instruments, lower-echelon and government communication, microprocessors, TV and video equipment, personal computers, security and fire alarms, cellular telephones, etc. A number of items and technologies have been patented in Japan, France, Great Britain, Germany and other countries. Many items and technologies have received medals at different international exhibitions.

Fonon has business connections with more than 200 enterprises, branch scientific research institutes and institutes of the Russian Academy of Sciences, institutions of higher education (Moscow State University, Moscow Physical Technical Institute, Moscow Institute of Physical Engineering, and others).

Development work by the institute has been introduced at 15 enterprises in Russia, the CIS countries and Bulgaria.

Particular mention must be made of the work of the institute in obtaining and using langasite in producing monolithic filters and tunable microoscillators, as well as new technologic methods for the forming of crystalline elements.

For example, the technology of chemical etching, in combination with photolithography, is making it possible to fabricate planar resonators, whereas plasmochemical etching will make it possible to obtain superthin crystalline elements down to 3 microns.

Modern methods for the processing of materials will make it possible to fabricate crystalline elements of any configuration and size. In general the institute has developed and can produce virtually all types and groups of piezoelectronic instruments.

A variety of piezoelectric resonators for general use and precision purposes operating in the frequency range from 10 kHz to 360 MHz, piezoelectric filters from 4 kHz to 210 MHz (including TV based on SAW), microoscillators up to 215 MHz and a number of transducers for medical and industrial applications have been developed and are in standard production.

A variety of instruments with different design-technologic finalization with a virtually complete series

of basic parameters, ensuring an annual full supply of electronic equipment has been developed.

Scientific research and development work on the following variety of items is being carried out in the resonator field:

— microresonators of flexural oscillations;

— ultraminiaturized tuning fork resonators;

— microresonators of longitudinal oscillations;

— microresonators of torsional oscillations;

— microresonators with thickness shear oscillations;

— highly stable and precision resonators·

— resonators based on strong piezoelectrics.

Technical Specifications

Small resonators with ultrathin crystalline elements

frequency — 30-300 MHz

frequency stability (-10 - +60°C) — +/-20 x 10^{-6}

harmonics — 1

retention of parameters — 20 years

Precision ultrastable resonators

frequency — 5 MHz

harmonics — 3-5

retention of parameters — 20 years

aging (during 30,000 hours) — 5 x 10^{-8}-2 x 10^{-7}

instability (per second) — 10^{-12}

The Following Items Are Being Developed in the Filters Field:

— monolithic quartz filters;

— monolithic lithium tantalate filters:

— monolithic langasite filters;

— surface acoustic wave filters

— IF filters based on B/G, D/K and M standards;

— filters for multistandard TVs;

— filters for satellite TV;

— filters for high-clarity TV;

— filters with rectangular and uniform passband

Typical monolithic quartz filters are produced in the frequency band from 2 to 150 MHz with passbands from 0.01 to 0.3 percent at the fundamental frequency in volumes from 0.14 to 1.4 cm^3. Monolithic lithium tantalate filters are produced in the frequency range from 5 to 28 MHz with passbands from 0.5 to 4.2 percent in volumes from 0.3 to 1.4 cm^3. Monolithic filters from langasite are produced for the frequency range from 5 to 18.5 MHz with passbands from 0.3 to 0.8 percent in volumes from 0.5 to 3.0 cm^3.

The Principal Advances in the Field of SAW Filters are:

— development of small-aperture filters (with aperture 2.5-3.5 wavelengths);

— design of SAW TV filters ensuring removal of more than 300 chips from a lithium niobate di[illegible] 3 [illegible]ches in diameter;

— tunable filters with switching of [illegible] frequency standard in channel for propagation of SAW without changes in input and output impedances;

— SAW filters with nonuniformity less than 0.3 dB and selectivity more than 60 dB.

SAW filters operating in the frequency range 10-500 MHz with a relative passband 0.1-40 percent of the f nominal are typical.

Items of the Following Variety Are Being Developed and Produced in the Microoscillator Field:

— simple quartz oscillators;

— quartz oscillators controlled by voltage;

— thermocompensated quartz oscillators;

— audio-range quartz oscillators;

— quartz oscillators with digital frequency compensation;

— small low-noise oscillators.

Principal Technical Specifications of Microoscillators:

frequency range — 1 Hz-1,000 MHz

frequency instability, 10^{-6} — +/-0.05-+/-5.0

tuning limits, 10^{-6} — +/-3.5-+/-300

power supply — 5-12 V

consumed current — 2-100 mA Microoscillators are fabricated on the basis of unhoused transistors of integrated microcircuits using TTL and CMOP technologies.

The Following Variety of Transducers Is Being Developed and Produced:

pressure, rarefaction, differential pressure, force, temperature, humidity, linear accelerations.

Produced on the basis of three-dimensional quartz oscillators, they all can be supplied as part of multichannel control-measuring systems with the following parameters:

number of measuring channels: from 4 to 1,256

measurement range:

pressure — 0.1-60 MPa

rarefaction — to minus 100 kPa

differential pressure — +/-200 Pa-1,000 kPa

force — from 0-10 gauss to 0-1 Ts

humidity — 28-98 percent

linear accelerations — 0-1-10 g

measurement accuracy

pressure, force, acceleration — +/-0.05-0.25 percent

temperature — +/-0.004-0.4 C

humidity to — +/-3.00

range of working temperatures — -60-+165°C

length of line coupling transducer to control-measuring instruments — up to 1,000 m

Fonon is now capable of routinely manufacturing and supplying, and, if needed, developing a wide variety of piezoelectric instruments taking in a great number of design-technologic varieties of piezoelectric devices in microminiaturized flat, cylindrical, metallic, glass and ceramic housings in the frequency range from a few Hz to hundreds of MHz, corresponding to current levels of electric and operational characteristics.

Project. Development of Designs and Organization of Production of Piezoelectric Filters

Piezoelectric filters are reference instruments for radio systems of different complexity: space and tropospheric communication systems, radars with continuous and quasicontinuous radiation and radars carried aboard different kinds of transport vehicles. The filters determine the selectivity and stability of any selective device. Their use makes it possible to broaden the frequency range of use of electronic radio equipment, sharply reduce the volume and weight of the equipment, increase its reliability, and ensure a number of specific requirements.

The filters have substantial advantages in comparison with analogues produced earlier in Russia and abroad, protected by patents (Patents N1634114, N1556504, N1780144, N1685234) and awarded diplomas by the Brussels International Exhibition in 1993.

Technical Specifications

Broadening of frequency range (relative to the fundamental frequency) 150 MHz

Increase in guaranteed attenuation to 80-100 dB

Increase in width of passband up to 4.0 percent

Decrease in dimensions to 0.15 cm

Work To Be Done Within Scope of Project

Development of monolithic filters based on reversible mesostructures;

Development of filters from new piezomaterials;

Development of a technology for standard production of filters;

Development and fabrication of technologic fittings;

Acquisition of technologic and metrologic equipment;

Preparations for and organizations of production sectors.

Times and Volumes

The production of filters can be initiated in 1995 and increased each year: 1995 — 30,000 units

1996 — 50,000 units;

1997 — 75,000 units;

1998 — 100,000 units.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 900,000 dollars. Form of funding — an advantageous loan for 3.5 years. If the stipulated amounts of production are met, the total recovery of the investment will be attained after three years. FONON Scientific Research Institute, 105023, Moscow Telephone: 269-28-10 Fax: 975-21-57

Project. Development of Designs and Organization of Production of Piezoelectric Resonators

The resonators are intended for frequency synthesizers of mobile receiving-transmitting communication systems (cellular radio telephone communication, distant communication equipment) for the manufacture and production of wide-band filters of receiving-transmitting equipment for the economy (geology, agriculture, etc.)

The quartz resonators fabricated with the use of a promising technology — chemical and ion-plasma form formation in the frequency range higher than 150 MHz — with respect to their parameters have no foreign analogues (experimental research is being carried out abroad).

Technical Specifications

Frequency range — 50-300 MHz

Tuning accuracy — +/-50 x 10^{-6}

Dynamic resistance — < 80 ohm

Temperature instability in range of working temperatures (-10/+60°C) — +/-50 x 10^{-6}

Volume — < 0.2 cm^3

Work To Be Done Within Scope of Project

Development of design and technology for standard production of resonators; Development and fabrication of technologic fittings, Acquisition of control-measuring and test equipment; Metrologic and certification testing

Times and Volumes

The production of quartz resonators can be initiated in 1995 and will increase each year (thousands of units).

1995 — 10.0;

1996 — 50.0;

1997 — 80.0

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 200,000 dollars. Form of funding — advantageous loan for 3 years. If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest will be the first half of 1998. FONON Scientific Research Institute, 105023, Moscow Telephone: 269-28-10 Fax: 975-21-57

Project. Development of Basic Technologies and Large-Scale Production of Quartz Resonators and Quartz Oscillators

Organization of "full-sway" production lines for large-scale production of:

- highly stable quartz resonators operating in the frequency range from 10 kHz to 50 MHz in housings compatible with surface mounting technology. Volume 10 million units/year.
- miniaturized highly stable audio oscillators operating in frequency range from 10 kHz to 500 MHz. Volume 35,000 units/year
- highly stable microminiaturized oscillators operating in frequency range from 8 to 20 MHz with power 5 V standard for IC. Volume 100,000 units/year
- Development of basic technologies similar to semiconductor technology
- Completion of construction of new production facilities

Times and Volumes

The time for implementing the projects is 2 years. The volume of sales will be 51 million dollars

Funding and Cost Recovery Period

The total amount of funding is 27 million dollars. The anticipated profit is 25 percent

Morion Joint-Stock Company, St. Petersburg

Project. Development of Designs and Organization of Production of Surface Acoustic Wave Filters

SAW filters are widely used in different radio and TV transmission and communication systems (repeaters, transmitters, demodulators, intermediate frequency elements of TV receivers, including fifth-generation), satellite communication systems, household decimetric receivers, systems for the identification of different objects, systems for protection of channels against unauthorized access, cellular communication systems, radio telephones, pagers and radar systems, including those for special purposes. They ensure a high selectivity of such systems, increase their reliability and make it possible to reduce the size of the equipment and meet a number of specific requirements.

The high quality of the development work is attributable to the use of original designs, protected by author's certificates and patents, as well a unique system for the synthesis and correction of amplitude-frequency curves, phase-frequency curves and GVZ [expansion unknown] of SAW filters. Such an approach will make it possible to meet complex technical requirements exceeding the level of world attainments existing at the present time with maximum efficiency and economy.

Technical Specifications

Working frequency range from 20 to 800 MHz;

Guaranteed attenuation 60-80 dB;

Decrease in introduced attenuation up to 2-6 dB

Work To Be Done Within Scope of Project

Development of new original designs of SAW filters;

Development of SAW filters using new sections of piezomaterials;

Development of new technologies for fabricating filters ensuring standard production of items;

Development and fabrication of technologic fittings;

Acquisition and development of required technologic and metrologic equipment.

Times and Volumes

The production of filters can be initiated in 1995 and will increase by years (thousands of units):

1995 — 50;

1996 — 100;

1997 — 700;

1998 — 1,200.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 800,000 dollars. Form of funding — advantageous loan for 3.5 years. If the stipulated amounts of production are met, total recovery of the investment will be attained after three years. FONON Scientific Research Institute, Moscow Telephone: 269-28-10 Fax: 975-21-57

Project. Development of Designs and Organization of Production of Quartz Oscillators With Frequency Temperature Compensation (TC) for FAPSI Equipment and High-Frequency FM Quartz Oscillators With Powerful Output

The quartz oscillators are intended for use as part of electronic communication equipment as a source of a signal with a highly stable frequency. The new oscillator design has considerable advantages in comparison with those developed in Russia and produced by the Impuls Plant (Ukraine), as well as foreign oscillators, as a result of use of integrated components (specialized microcircuits and single-crystal microprocessors).

Several dozen customers in Russia and foreign countries are now interested in the standard production of these oscillators.

Technical Specifications

Frequency range: 2-12 MHz (with TC); up to 200 MHz (for FM);

Temperature instability: +/-2.5 x 10^{-6}; +/-5.0 x 10^{-6} in range of working temperatures 60-85°C (with TC);

Adjustment limits: +/-100 x 10^{-6} (for FM);

Volume: 6 cm^3, 2 cm^3

Work To Be Done Within Scope of Project

— development of a design of an oscillator for standard production;

— development of fabrication technology for standard production;

— development and fabrication of technologic fittings;

— acquisition of technologic and measuring equipment;

— preparations for and organization of production;

— metrologic and certification testing.

Times and Volumes

Production can be initiated in 1994 and will increase each year (in thousands of units):

1994 — 5.0;

1995 — 70.0;

1996 — 140.0;

1997 — 280.0.

The approximate price of the oscillators is 25-50 dollars.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the program will be 500,000 dollars. If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1995. The time for full repayment of the loan with interest will be 1996. FONON Scientific Research Institute, Moscow Telephone: 269-28-10 Fax: 975-21-57

Project. Development of Designs and Organization of Production of Piezoresonance Transducers and Equipment Based on Them

The transducers are produced in variants resistant to corrosion, are protected against explosions and sparks, and are intended for use in the oil and gas industry, hydrophysics, medicine, food industry, space research, seaborne equipment, etc., etc.

In comparison with transducers of the Sapfir 22 type widely used in Russia, the transducers will have a higher measurement accuracy in the temperature range, lesser production cost, higher time stability, considerably lower power consumption, and the possibility of working on a long line without an accuracy loss.

Technical Specifications

Measurement range

— for pressure: 0-1 - 0-60 Mpa

— for differential pressure: 0.500 Pa - 0-10 MPa

— for force: 0-0.1 - 0-100 kgauss

Principal error: 0.1-0.25 percent

Range of working temperatures: -60°C - +85°C

By special order: up to +200°C

Additional temperature error when using active thermal compensation scheme using built-in miniaturized tuning fork temperature transducer: 0.001-0.005 percent/C.

Amplitude of output signal with load 100 kohm: 0.6 V

Power voltage: 4-12 V

Consumed current: not more than 10 mA

Number of typonominals

— for pressure: 14

— for differential pressure: 15

— for force: 20

Work To Be Done Within Scope of Project

— development of design of about 50 types of transducers for pressure, differential pressure and force and the technology for their fabrication;

— preparation of a set of design, technologic and textual documents;

— development and fabrication of technologic fittings and test equipment;

— organization of sector for fabrication of component parts of transducers and their assembly, testing and certification;

— preparations for and organization of production;

— conducting of metrologic and certification tests;

— conducting of marketing research.

Times and Volumes

The production of the transducers can be initiated in the second half of 1996. The average price of the transducers in prices of the fourth quarter of 1994 is about 350,000 rubles/unit.

Volume of production:

1996 — 500 units;

1997 — 5,000 units;

1998 — 10,000 units;

1999 — 30,000 units;

2000 — 50,000 units.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 1.5 billion rubles.

Form of funding — advantageous loan for 3.5 years. If the stipulated production volumes are met the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest is the first half of 1999. FONON Scientific Research Institute, 105023, Moscow Telephone: 269-28-10 Fax: 975-21-57

Radio Parts and Radio Components

V. P. Buts, Yu. A. Pimenov and V. Ya. Tsilinskiy

Resistors

With respect to their technical indices Russian variable nonwire resistors in general are at the level of the products of foreign companies (Bourns, Clarastat, United States; Tokyo Cosmos, Alps, Japan; Philips, Holland; and others), being somewhat inferior to them with respect to the level of stability of parameters. At the present time in world practice the development of variable nonwire resistors is proceeding in the direction of improvement in the design-technologic and functional features of items (resistors of modular design, for surface mounting, ultraflat and low-profile). Provision is made for developing a new generation of variable nonwire resistors based on use of group technologic processes for manufacture of parts and assembly with a maximum standardization of design, technology and equipment, which will ensure the economical production of high-quality items.

The basis for the technologic processes of their manufacture is the process of assembly of units and items as a whole on an assembly line belt, which will simplify assembly equipment and its operation.

The development of resistors on the basis of basic designs will make it possible to improve their user properties and organize their production in conformity to user requirements.

Passive Membrane Element Assemblies (PMEA)

On the basis of thick-film technology for the application of resistive, conductive and dielectric layers, the Giperon Special Design Bureau has developed a new class of items — electrotechnical assemblies of passive elements which perform the functions of variable

nonwire resistors with linear (circular) movement of a moving contact, and in combination with switching elements constitute items which are regulating and control devices in equipment.

Membrane control assemblies have a lesser size, high resistance to wear and number of switchings of a hundred thousand or more, improved adjustment characteristics (movement noise 15-30 mV, imbalance +1 db), convenience in mounting by a flexible loop and increased ergonomic possibilities.

Provision is made for creating single-band, multiband and integrated, including with switching, assemblies of passive membrane elements for use as variable nonwire resistors, in particular for replacement of SP3-23, RP1-68 and RP1-69 resistors, as well as in systems for control of electronic keyboard units.

There are no known foreign analogues of PMEA. This development work may be protected by Russian Federation patents.

The use of PMEA will make it possible to develop new models of electronic equipment competitive on the world market (equalizers, sound reproducing and sound recording systems) and widely used household electronic appliances (sewing machines, mixers, etc.)

High-Voltage Dividers and Items Based on Them

High-voltage divider assemblies are finding wide application both as part of diode-line scanning transformers (DLST) and in the form of integrated voltage dividers in TV and video equipment, video monitors, medical equipment, control systems and other electronic equipment.

Provision is made for conducting a work program on development of the design and technology for the production of high-voltage items for the broadening of a variety of instruments for incorporation in different types of TV and display equipment. The technical specifications of the high-voltage items proposed for development are at the level of the best foreign analogues.

Switching Devices

Taking into account the real need of Russian industry for switches, the following trends in their development are noted:

With respect to variety:

- general-use switches used as network switches, command switches for closing and opening power circuits for currents up to 8 A and a voltage 250 V and providing great startup currents, with increased light engineering characteristics, including those protected against dust and spray, for three-dimensional mounting in electronic equipment, lathes for mechanical processing, industrial control equipment, equipment for control of technologic processes, as well as in medical diagnostic instruments;
- switches for weak-current circuits intended for printed circuitry, including circuits protected against dust and spray with switching currents of several milliamperes and a voltage up to 36 V (5 V);

With respect to specifications:

- for a lower limit of switched currents and voltages from 1×10^{-6} A and 1×10^{-4} V;
- weight and size characteristics, including profile of switching devices (SD) up to 4-4.5 mm;
- increase in reliability, useful life and durability;
- increase in ergonomic characteristics with respect to light indication, form of drive elements, attachment elements and tactility of switching.

The development of small equipment of a qualitatively new type meeting the requirements for reduction of power consumption, including power units not embodying a transformer, requires the use of button switches having increased reliability and adequate speed. For such systems provision is made for the development of a number of miniaturized button switches with and without a stop, including with light indication, intended for the switching of a wide range of currents and voltages. These switches have a wear resistance up to 100,000 switching cycles and a triggering time (time of switching of contacts) 0.3-0.5 ms, making it possible to reduce the arcing time and thereby reduce the erosion of the contacts and increase the useful life of the switches.

Such button switches are finding use as network and command switches in different types of electronic radio equipment, including household appliances, industrial machines (lathes with numerical control) and switches aboard vehicles.

There is a great demand for the simplest designs of switches corresponding to the requirements of automated or highly mechanized production. These include low-profile membrane button switches which have a good tactility and are finding broad application in different kinds of control panels, in portable receiving-transmitting devices, TV and video equipment and in adapters. Here consumers impose special requirements: protection against dust and spray, resistance to increased temperatures and resistance to impact loads. With an increase in the complexity of electronic radio equipment

there is a trend toward miniaturization and an increase in the density of wiring. A need is appearing for surface on printed circuit boards. Abroad there is a wide range of low-profile switches with lead-outs in designs protected against the entry of moisture Among the companies traditionally advertising such low-profile button switches are Omron, Alps, Hosiden (Japan) and GTT (United States).

A serious problem in surface mounting is the cleaning of the printed circuits of flux accompanying soldering. Russian industry has in standard production a number of membrane button switches PKn125 (12 x 12 x 4.5), PKn159 (6.5 x 6.5 x 3.5) with circuit board mounting, and work is being done to ensure their suitability for special equipment.

Subsequent work will be directed toward:

- development of small button switches protected against dust and spray and corresponding to modern requirements of electronic radio equipment with respect to technical parameters and reliability in operation;
- development of low-profile switches with surface mounting protected against dust and spray using conducting polymers not containing precious metals, which will make it possible to reduce work input and cost of items by 15-20 percent.

For the automobile and tractor branches it is necessary to have switches resistant to the penetration of moisture and foreign particles and the influence of machine oils and lubricants. Provision is made for the development of button switches protected against dust and spray with light indication and with an increased reliability in the sizes: 19.8 x 19.8 x 65 (with stop), 19.8 x 19.8 x 50 (without stop), switching loads 1 x 10^-4 A, 3-36 V, wear resistance 50,000 switching cycles.

To ensure the planned work on developing promising SD and organizing their production it is necessary to use fundamentally new technologies, group technologies for the fabrication of parts and assemblies, tape technology for the fabrication of SD, use of thermoplastic materials and automated assembly and checking.

To reduce the use of precious metals it is necessary to carry out development work on new thicknesses of coatings. In this direction work will be done to finalize a technology for applying silver and gold coatings under stationary electrolysis conditions, which will make it possible to obtain denser coatings having high electrophysical and mechanical properties, including pore-free coatings with increased resistance to corrosion and a smooth, shiny surface in comparison with standard coatings.

In addition, technologic nonstationary electrolysis processes have been developed for the application of nickel and tin coatings.

The application of multilayer coatings of precious and nonferrous metals by nonstationary electrolysis will make it possible to obtain virtually pore-free coatings beginning with 1 μm. The use of this technology has made it possible to reduce the thickness of silver coatings from 3 μm to 1 μm and to increase the productivity of the process by means of an increase in the rate of precipitation of precious metals by a factor of 5-6 and nonferrous metals by a factor of 2-4.

Data Input Devices

Modern keyboards are complex electronic-mechanical devices ensuring interaction between the user and the computer system.

The industrial standards have come to be 84-, 101-, 102- and 122-key keyboards. Due to the widespread introduction of IBM computer clones, the use of IBM compatible keyboards has become most common. Great attention is being devoted to the development of "low-noise" keyboards. At the present time it is possible to organize the large-scale production of both IBM=PS XT/AT, PS-2 compatible keyboards and keyboards for MacIntosh systems, as well as specialized special-order keyboards.

Keyboards have been produced which operate in extreme temperature ranges (from -60°C to +85°C) and which are resistant to mechanical agents (including those which are resistant to dust and moisture), satisfying modern design requirements.

At the same time work is being done to create alternative devices for data input such as:

— data input devices of the "mouse" type for the input of verbal information;

— specialized data input devices and units (including coding devices);

— panel and unit data input devices.

Principal Parameters of Keyboard Units

Dimensions, mm: 505 x 200 x 45

Weight, not more than, kg: 2.5

Stroke pressure, N, not greater than: 2.5

Key stroke, mm: 4+0.4

Number of switching cycles, up to: 5 x 10

Power voltage, V: 5(+0.25; -0.15)

Consumed current, A, not more than: 0.2

Levels of transmitted and received signals, V:

log "0," not more than — 0.4

log "1," not less than — 2.4

Type of interface — IRPS Type of codes — compatible with IBM XT/AT

Principal Parameters of Passive Commutation Panels

Dimensions, mm:

unit 3 x 4 (square drive): 70 x 55 x 6

unit 3 x 4 (circular drive): 60 x 50 x 5

Weight, kg, not more than: 0.2

Stroke pressure before triggering, N, not more than: 3

Key stroke, mm: not more than 2

Range of commutated d-c current (under an activated load), A: 1×10^{-6} - 1×10^{-1}

Commutated voltage, V:

maximum: 36

minimum: 1×10^{-4}

Resistance of electric circuit of switches in closed state, ohm: not more than 500

Resistance of insulation between current-conducting parts (open contacts) in NKU, Mohm: not less than 20

Contact jitter time, s: not more than 10^{-2}

Project. Variable Nonwire Resistors

The development of variable nonwire resistors of a new generation on the basis of group technologic processes.

Development of high-voltage voltage divider units and items based on them for image display devices.

Development of units of membrane passive elements based on flexible polymer films.

The work is protected by an Author's Certificate and six Russian Federation patents.

Technical Specifications

Resistors of a modular design, including for surface mounting

Nominal power: 0.05-0.5 W

Size: 5 x 5; 10 x 12; 16 x 16 mm

Wear resistance (for adjustment purposes): 10,000-30,000 cycles

The resistors are miniaturized for small household electronic appliances

Nominal power: 0.01-0.05 W

Maximum working voltage: 5.0-50.0 V

Wear resistance (for adjustment purposes): 10,000-25,000 cycles

Resistor transducers

Nominal power: 0.063 W

Wear resistance: 100,000 cycles

Integrated units, including with additional resistances and capacitances

Nominal voltage: 30 kV

Resistance to d-c current: 330-1,000 Megohm

Capacitance: 4,500 pF

Diode-line transformers

Working voltage: 30 kV

Nominal d-c current: 10 A

Nominal frequency: up to 64 kHz

Single- and multi-channel units of passive membrane items for household electronic appliances

Number of bands: 4-10 units

Nominal resistance: 470-1 x 10 ohm

Number of movement cycles: 200,000-300,000

Integrated units of passive membrane elements, including with switchings

Number of bands: up to 10 units

Number of movement cycles: 100,000-500,000 cycles

Number of switchings: 300,000 units

Times and Volumes

The production of variable nonwire resistors was initiated in 1994 and can increase each year (millions of units):

1995 — 10.0;

1996 — 100.0;

1997 — 200.0.

Work To Be Done Within Scope of Project

- Development of electronic equipment items ... 16

- scientific research and design studies Construction and improvement of technologic processes ... 4
- design studies Design of equipment ... 10
- design studies Development of materials ... 7
- scientific research and design studies

Funding

The approximate amount required for funding the development work under the programs of the enterprises is 3 billion rubles.

Cost Recovery Period

If the stipulated volume of work under the program is performed, costs will be recovered in total in 1998.

Giperon Special Design Bureau, Moscow

Project. High-Frequency, High-Voltage Polarized Vacuum Relays

Development of a technology and organization of large-series production of P2D-1V, P4D-1V vacuum relays operating at working voltages from 3 to 5 kV and transmitted currents from 15 to 25 A at a frequency 30 MHz with range of working frequencies up to 80 MHz.

These vacuum relays are intended for use in radio transmitting and communication equipment for switching of high-voltage, high-frequency circuits in them, resonance circuits, filters for suppression of harmonics, capacitors in antenna-matching devices, etc. Their use increases reliability, speed and power transmitted to the antenna with a reduction in the weight and size characteristics of the equipment.

With respect to its electric parameters these relays of the polarized type have no foreign analogues.

Technical Specifications

Working voltage at frequency 30 MHz,

kV P2D-1V — 3.0

P4D-1V — 5.0

Transmitted current at frequency 30 MHz,

A P2D-1V — 15

P4D-1V — 25

Range of working frequencies, MHz: up to 80

Approximate price: from 150 to 250 dollars

Work To Be Done Within Scope of Project

- Development of a technology for large-series production;
- Development and fabrication of technologic fittings;
- Acquisition and development of technologic and test equipment;
- Metrologic and certification testing.

Times and Volumes

The production of vacuum relays can be initiated in 1995 and will increase each year (thousands of units):

1995 — 1.0;

1996 — 4.0;

1997 — 10.0;

1998 — 20.0

Funding and Cost Recovery Period

The approximate investment required for implementing the work program will be 400,000 dollars. The form of funding is an advantageous loan for 3 years.

If the stipulated volumes of production are met, the investment will be totally recovered in 1997. Total repayment of the loan with interest will be due in the first half of 1998.

Electronic Measuring Instruments Scientific Research Institute, Penza Telephone: (8.8412) 64-57-42; 64-81-40

Project. High-Frequency High-Voltage Unpolarized Vacuum Relays

Development of a technology for and organization of large-series production of vacuum relays of the P1D-3V, P2D-2V types operating on working voltages from 3 to 5 kV and transmitted currents from 1.5 to 5 kV and transmitted currents from 2 to 12 A at a frequency 30 MHz with a range of working frequencies up to 80 MHz.

The vacuum relays are intended for use in radio transmitting and communication equipment for the switching of high-voltage, high-frequency circuits, resonance circuits, filters for the suppression of harmonics, capacitors in antenna-matching devices, etc. Their use is increasing reliability, speed and power transmitted to the antenna with a reduction in the size and mass characteristics of the equipment.

With respect to electric parameters and operating modes they are in no way inferior to foreign analogues (FL Jennings, United States, Siemens, West Germany).

Technical Specifications

Working voltage at frequency 30 MHz

P1D-3V — 1.5 kV

P2D-2V — 5 kV

V1D-2V — 2.5 kV

V1D-3V — 4 kV

Transmitted current at frequency 30 MHz

P1D-3V — 7.5 A

P2D-2V — 12 A

V1D-2V — 5 A

V1D-3V — 5 A

Range of working frequencies: up to 80 MHz Approximate price: from 40 to 200 dollars

Work To Be Done Within Scope of Project

- Development of a technology for large-series production:
- Metrologic and certification testing

Times and Volumes

The production of vacuum relays can be initiated beginning in 1995 and will increase each year (thousands of units):

1995 — 2.0;

1996 — 10.0;

1997 — 30.0;

1998 — 60.0.

Funding and Cost Recovery Period

The approximate investment required for implementing the work program will be 500,000 dollars. Form of funding — advantageous loan for 3 years.

If the stipulated production volumes are met, total recovery of the investment will be attained in 1997. The full repayment of the loan with interest is due the first half of 1998.

Electronic Measuring Instruments Scientific Research Institute, Penza Telephone: (8.8412) 64-57-42; 64-81-40

Project. Galvanotechnology

Development of technologies and equipment for the production of switching devices directed at saving precious metals by the application of new scientific-technical solutions: use of nonstationary modes for the precipitation of nonferrous and precious metals for the purpose of reducing the thickness and improving the quality of coatings and also for increasing process productivity.

The technologic process is intended for coating with ferrous and precious metals and will make it possible to obtain: — multilayer coatings with different functional properties of each layer; — high resistance to corrosion due to the exclusion of porosity; — small thickness of coatings with retention of quality and operational characteristics; — automatic change in the percentage content of alloying additives in melts.

Technical Specifications

Reduction in thickness of coverings by a factor of 2-5 without worsening of quality of products.

Increase in productivity of process by a factor of 5-10, depending on purpose of the covering.

Increase in resistance of coatings to corrosion by 50 percent.

Obtaining of coatings with stipulated functional properties (hardness, internal stresses, etc.).

A high efficiency of the technical processes is attained by the use of programmable sources of an unsteady current.

Work To Be Done Within Scope of Project

- Development of technologies for large-series production:
- Development and fabrication of technologic fittings
- Development and fabrication of special technologic equipment and sources of unsteady current
- Standardization of new quantities for coatings with lesser thicknesses

Times and Volumes

The development and introduction of industrial technologies and equipment in the electronics, radio and other related branches beginning in 1995.

Funding and Cost Recovery Period

The approximate investment required for implementing the work program will be 3 million dollars.

If the stipulated volumes of production are met, full costs will be recovered by 1997.

Radio Components Scientific Research Institute, Moscow Telephone: (095) 236-13-54

Project. Push-button Switches Protected Against Dust and Spray

Development of low-profile push-button membrane switches, including for surface mounting, with protection against dust and spray.

They are intended for the switching of a-c and d-c current circuits in different control, signaling and monitoring systems when there is exposure to dust and moisture.

Their use in equipment will make it possible to reduce the weight and size characteristics, will reduce production expenditures and save on materials in short supply due to dispensing with special devices for protection against dust and spray.

Technical Specifications

Switched current: 1 μA-0.1

A Switched voltage: 100 mV-36 V

Resistance to wear: 100,000 cycles

Minimum useful life: 25,000 hours

In mode operation: 500,000 hours

Dimensions: 6.5 x 6.5 x 4 mm; 12 x 12 x 5 mm

Work To Be Done Within Scope of Project

- Development of design of push-button switch in form protected against dust and spray for mounting in openings on circuit boards and on their surfaces
- Development of an automated production technology
- Acquisition of highly productive technologic equipment
- Development of special sealing materials
- Preparations for and organization of standard production

Times and Volumes

Production must be initiated in 1997:

1997 — 200,000 units;

1998 —500,000 units.

Funding

Total amount: 800 million rubles.

Radio Components Scientific Research Institute, Moscow. Telephone: (095) 236-13-54

Project. Push-button Switches With Light Indication Protected Against Dust and Spray

Development of push-button switches with light indication protected against dust and spray with increased reliability.

Intended for use in vehicles (tractor and automobile industries) exposed to dust, moisture, industrial oils and lubricants.

These switches make it possible to increase the reliability of vehicles, reduce expenditures on the manufacture of control panels and ensure a modern design in the driver's cab.

Technical Specifications

Switched current: 1 μA-4

A Switched voltage: 3-36 V

Resistance to wear: 50,000 cycles

Stroke: 4.0-7.0

Switching force: 14-22 N

Dimensions: 19.8 x 19.8 x 50 mm; 19.8 x 19.8 x 65 mm

Work To Be Done Within Scope of Project

- Development of design of push-button switch with illumination, with and without stop with sealing from the panel side
- Development of standard production technology
- Acquisition of necessary equipment
- Preparations for and organization of production

Times and Volumes

The production of these push-button switches must be initiated in 1997:

1997 — 50,000 units.

1998 — 300,000 units.

Total value of production: 450 million rubles

Radio Components Scientific Research Institute, Moscow, Telephone: (095) 236-13-54

Project. Push-button Switches With Increased Reliability

Intended for use for network and command purposes in modern equipment with a low power consumption (power units of a new type, secondary power sources).

With respect to the set of parameters — wide range of switched loads, minimum triggering time, small dimensions and increased reliability —they have advantages in comparison with existing Russian switches and correspond to the level of foreign analogues. (There is a patent No 92-0114585/07).

Technical Specifications

Switched current: 1 μA-8

A Switched voltage: 100 mV-250 V

Wear resistance: 100,000 cycles

Triggering time: 0.3-0.5 ms

Switching force: 0.4-1.1 N

Dimensions: 12.5 x 8 x 16 mm; 12.5 x 12.5 x 16 mm

Work To Be Done Within Scope of Project

- Development of design of push-button switches with and without stop, including with color and light indication
- Development of mass production technology
- Acquisition of necessary technologic equipment (equipment for 2-pass moldings)
- Provision with materials (high-temperature press materials and equipment for their reworking)
- Organization of large-scale production

Times and Volumes

The production of push-button switches should be initiated in 1996; beginning in 1995 — delivery of small consignments:

1996 — 400,000 units;

1997 — 1 million units.

Funding

Total amount: 1.5 billion rubles, including expenditures on organization of production — 1 billion rubles.

Radio Components Scientific Research Institute, Moscow Telephone: (095) 236-13-54

Project. Push-button Switches With Light Indication

Developing and putting into production of push-button switches with improved light engineering characteristics.

They are intended for use in aviation and the shipbuilding industry.

They will make it possible to increase the reliability of control panels for airborne and ship-borne equipment.

Technical Specifications

Error-free perception of light and color indication with external illumination up to 80,000-100,000 lux. Resistance to wear: 100,000-1,000,000 cycles

Work To Be Done Within Scope of Project

- Development of design of push-button switches with and without a stop with improved light engineering characteristics;
- Development of a technology for the standard production of items;
- Organization of work for acquisition of materials: heat-resistant thermoplastic plastics, color silicate glasses for light filters and a technology for their fabrication; templene with the necessary characteristics;
- Choice of light-producing elements (lamps, light-emitting diodes, luminescent panels, symbol-synthesizing indicators);
- Acquisition of equipment for checking light engineering characteristics;
- Preparations for mastery and organization of standard production.

Times and Volumes

Production must be initiated in 1997:

1997 — small deliveries;

1998 —50,000 units;

1999 — 100,000 units.

Funding

Total amount: 2 billion rubles.

Radio Components Scientific Research Institute, Moscow. Telephone: (095) 236-13-54

Project. DIP Switches

Development of a technology and organization of standard production of low-profile DIP switches for surface mounting.

The DIP switches are intended for intra-unit mounting in new types of electronic equipment and computers.

They will make it possible to reduce the size of electronic equipment and to increase its reliability.

Technical Specifications

Switched current: 1 μA-0.1 A

Voltage: 0.1 mV-36 V

Wear resistance: 2,000 cycles

Minimum useful life: 25,000 hours

Work To Be Done Within Scope of Project

- Development of technology for DIP switches for surface mounting.
- Development of technologic processes for standard production.

Times and Volumes

Performance of work in 1995-1998.

1998 — 50,000 units,

1999 — 100,000 units

Funding

The approximate amount of funding required is 450 million rubles.

Project. Sealed Switches

Development of sealed microswitches and organization of their standard production.

They are intended for use in electrical circuits of various actuating mechanisms, in circuits for signaling and monitoring control systems for special-purpose equipment, as well as in equipment operating under conditions of exposure to external factors: increased temperature of +200°C, a vacuum and aggressive liquid and gaseous media.

Technical Specifications

Switched current: 1 μA-4 A

Voltage: 127 V (0.1 mA)

Weight: 5.6 g

Wear resistance: 50,000 cycles.

Work To Be Done Within Scope of Project

- Developing a standard technology for bonding a metallovitreous seal
- Developing a standard technology for the fabrication of housing parts
- Setting up a work area for sealing and evacuation processes
- Setting up an assembly work area
- Organization of standard production

Times and Volumes

Standard production beginning in 1996. Delivery of small consignments in 1995.

Funding

Total amount: 1.2 billion rubles, including expenditures on the organization of production — 600 million rubles.

Radio Components Scientific Research Institute, Moscow. Telephone: (095) 236-13-54

Project. Sources of Secondary Electric Power

Development of a number of power sources of the resonance type with improved characteristics for electronic equipment based on the latest component base.

These power sources of the conversion type operating at a high frequency are intended for a broad range of electronic equipment.

The developed power sources have advantages over those existing at the present time with respect to the minimum level of pulsation, increased efficiency and reduced size.

Technical Specifications

Power, W: 30-200

Number of channels: 1-3

Specific power, W/dm

1 channel: 180

3 channels: 100

Pulsation factor, percent: 1

Efficiency, percent

1 channel: 75

3 channels: 80

Work To Be Done Within Scope of Project

- Development of fundamental electric circuits for resonance power sources
- Development of special electromagnetic components.
- Development of a number of power sources of the resonance type with a power up to 200 W.
- Mastery of production of power sources.

Times and Volumes

The production of the power sources can be initiated in 1997.

1997 — 1,000 units;

1998 — 5,000 units;

1999 — 10,000 units

Funding and Cost Recovery Period

The approximate amount of funding for 1995-1996 is 600 million rubles.

If the stipulated volumes of deliveries are met, costs will be recovered in full in 1999.

Radio Components Scientific Research Institute, Moscow. Telephone: (095) 236-13-54

Project. Power Transformers

Development of a new generation of transformers for conversion of power sources with improved design and electromagnetic characteristics.

Transformers with increased specific characteristics with reduction of no-load current for power sources of the resonance type.

They are recommended for broad use.

Technical Specifications

Power: 0.1-300 VA

Flattened design: height up to 15 mm.

No-load current 2-3 times lower than in existing designs.

Work To Be Done Within Scope of Project

- Development of a series of ferrite cores of a new configuration with a permittivity 10,000
- Development of a series of transformers for the principal types of electronic equipment, including night vision instruments
- Development of a technology for their production
- Preparations for and organization of production

Times and Volumes

1996 — 1,000 units;

1997 — 5,000 units;

1998 — 50,000 units;

1999 —100,000 units.

Funding and Cost Recovery Period

The approximate amount of required funding in 1995-1996 is 300 million rubles.

If the stipulated deliveries are made in the above-mentioned quantities, recovery of the investment will be attained in 1999.

Radio Components Scientific Research Institute, Moscow, Tel: (095) 236-13-54

Project. Fuses

Development of a technology and introduction of large-series production of fuses of VPT21 type with ampere-second characteristics corresponding to IEC Publication 127.

Fuses of the VPT21 type are intended for protection and increasing the reliability of a wide range of electronic equipment.

The fuses fully correspond in their ampere-second characteristics and design to the best foreign copies, but in cost are less than foreign copies.

Technical Specifications

Ampere-second characteristics in conformity to IEC Publication 127.

Triggering current	Triggering time
2.1 A	120 s
2.75 A	0.6-10 s
4 A	0.25-3.0 s
10 A	0.03-0.3 s

Maximum working voltages — 250 V

Length — 20 mm

Diameter — 5.2 mm

Work To Be Done Within Scope of Project

- Development of a technology for large-series production of fuses
- Development of technologic fittings
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of VPT21 fuses can be initiated in 1996, assuming that funding begins on 1 January 1995.

Production, millions of units

1996 — 15;

1997 — 30;

1998 — 45.

Funding and Cost Recovery Period

The approximate amount of required funding will be 600 million rubles.

If the stipulated volumes of deliveries are met, costs will be totally recovered in 1998.

Project. Multiple-Action Fuses

Research on, development and further improvement of multiple-action fuses.

Multiple-action fuses are intended for the electrical protection of household electronic equipment.

Technical Specifications

Current triggering, A — up to 3

Number of triggerings — up to 20

Work To Be Done Within Scope of Project

- Development of crystalline polymer with carbon filler
- Development of technology for reprocessing this polymer
- Development of a number of typonominals of multiple-action fuses
- Development of a technology for fabricating fuses
- Preparations for and organization of production

Times and Volumes

Development and initiation of experimental production in 1996

Production, millions of units:

1996 — 1.0;

1997 — 7.0;

1998 — 10.0.

Funding and Cost Recovery Period

The amount of funding for implementing the work program in 1995-1996 will be 200 million rubles.

The period for recovery of costs is 3 years.

Radio Components Scientific Research Institute, Moscow Telephone: (095) 236-13-54

Project. Data Input Device

Development of a technology for the production of a data input device of the "mouse" type for a personal computer of the type IBM PC (XT/AT, PS1, PS2) and MacIntosh.

Organization of their large-series production using a Russian component base.

Technical Specifications

Software-hardware compatibility of keyboard with PC type of IBM PC (XT/AT, PS1, PS2) and MacIntosh types and all software systems.

Assurance of low power consumption due to use of specialized controller based on CMOS technology.

Provision for protection against dust and moisture.

Modern design.

Work To Be Done Within Scope of Project

- Development of technology for large-series production
- Development and fabrication of technologic fittings
- Development of technologic and test equipment
- Preparations for and organization of production
- Metrologic and certification testing
- Organization of warranty servicing

Times and Volumes

The production of a data input device of the "mouse" type for personal computers of the type IBM PC (XT/AT, PS1, PS2) and MacIntosh can be initiated in 1995 with a buildup of production to 100,000 units in 1998.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 500,000 dollars.

A period of 1-1.5 years will pass before reaching the planned volumes of production and sales.

Project. Protected Keyboard

Development of a technology for the production of a nonradiating, low-noise keyboard for personal computers of the IBM PC (XT/AT, PS1, PS2) and MacIntosh types and organization of their large-series production.

Technical Specifications

Hardware-software compatibility with personal computers of the IBM PC (XT/AT, PS1, PS2) and MacIntosh types.

Assurance of protection against authorized access to commercial and economic information.

Reduction in level of EM radiation in range from 300 MHz to 40 dB.

Provisions for protection against dust and moisture.

Modern design.

Work To Be Done Within Scope of Project

- Development of a technology for large-series production
- Development and fabrication of technologic fittings
- Development of technologic and test equipment
- Preparations for and organization of production
- Metrologic and certification testing
- Organization of warranty servicing

Times and Volumes

The production of keyboards can be initiated beginning in 1995 with a buildup of production to 100,000 units in 1998.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 600,000 dollars.

Once the planned production and sales volumes are reached, costs will be recovered in 1.5-2 years.

Radio Components Scientific Research Institute, Moscow Telephone: (095) 236-13-15

Project. Microprocessor Microohmmeter

Development of the technology and organization of large-series production of microprocessor microohmeters.

The microprocessor microohmmeter is intended for operation with power cords up to 20 m in length in the presence of an electromagnetic field with a strength up to 25 kV/m.

The microohmmeter has substantial advantages in comparison with similar Russian instruments and has undergone successful tests at a number of 500-kV substations and is recommended for broad use by the Samaroenergo Joint-Stock Company.

Technical Specifications

Measurement range from 0.1 μohm to 1.0 ohm;

Principal reduced measurement error:

in range from 0.1 μohm to 1.0 mohm it does not exceed 1 percent;

in range from 1.0 mohm to 1.0 ohm it does not exceed 0.5 percent;

Power voltage 220+22 V;

Frequency of power voltage 50+2 Hz;

Consumed power does not exceed 40 W;

Dimensions: length 375 mm, width 355 mm, height 164 mm;

Weight does not exceed 5 kg;

Approximate price 750-1,000 dollars.

Work To Be Done Within Scope of Project

- Development of a technology for large-series production
- Development and fabrication of technologic fittings
- Acquisition and development of technologic and test equipment
- Metrologic and certification testing

Times and Volumes

Production can be initiated in 1995 and will increase each year:

1995 —75 units;

1996 — 2,500 units;

1997 — 5,000 units;

1998 units — 5,000 units.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program will be 2 million dollars. Form of funding: advantageous loan for 2 years.

If the stipulated volumes of production are met, total recovery of the investment will be attained in 1996.

Electronic Materials Industry Scientific Research Institute, Penza Telephone: (8.8412) 64-57-42; 64-81-40

Project. Production of Wide-Purpose Sealed Contact Assemblies

The plant produces more than 15 types of sealed contact assemblies for different purposes in the economy and in defense technologies.

Sensors of the impact and magnetic types and systems for safeguarding various objects have been developed on the basis of sealed contact assemblies (magnetically controlled contacts) and put into production. The principal user of the security systems is the Main Administration of Extradepartmental Security, RF Ministry of Internal Affairs.

These items are highly competitive, correspond to the best foreign analogues and ensure reduction of purchases from abroad.

The production of the Okno-5 modernized noise-immune protective system with improved characteristics will be initiated in the first quarter of 1995. The introduction of modern sensors and signaling security systems on the basis of sealed contact assemblies will make it possible to increase the probability of detection and prevention of the looting of estate and private property.

The annual savings from their introduction in Russia will be about 5.6 billion rubles.

Series of import-replacing automobile sensors for the level of oil and fluid in automobiles have been put into production. Sensors for any type of automobiles can be developed on this principle.

During the first half-year of 1995 the plant will initiate the production of ionic batteries and charging devices for them, replacing storage batteries and other power sources; they are characterized by ecological cleanness and a long useful life.

RZMKP Special Design Bureau, Ryazan Telephone: (0912) 93-01-21, 44-56-43 Fax: (0912) 93-01-21

Basic and Practical Research in Highly Important Electronic Technology Fields

V. I. Ivanov and Ye. I. Shulgin

The present status of the Russian electronics industry is characterized on one hand by inadequate competitiveness of items and technologies on the world market of scientific-technical products, and on the other hand, by a high scientific level of basic and practical research (BPR), much scientific research already done by scientific groups of highly qualified scientists and engineers in the electronics industry, Academy of Sciences and institutions of higher learning. Study of the market for scientific-technical products in the BPR (publications, participation in conferences, assignment of leading specialists abroad) shows that in a number of highly important fields (quantum nanoelectronics, microwave electronics, use of the high-temperature superconductivity effect in electronics, etc.) Russian research is successfully competing with Western research.

The solution of the principal timely problems defined in the BPR subprogram is directed at attaining the principal goal of the Russian State Program — supplying the national economy with modern electronic equipment items, instruments and articles based on them and entry of Russian electronics into the world market of technologies with a high scientific input, which is impossible without retention and further development of the priority of Russian science, creation and efficient use of scientific development work (BPR). The purposeful orientation of BPR on the solution of economic problems is combined with its military-technical significance, not expressed in explicit form, determined by the fact that most of the electronic items are dual-purpose items and the attainment of a high technologic level of the electronics industry provided for in the Program will make it possible to develop and produce electronic equipment items for military and military-technical purposes with allowance for the specifics of their requirements. The solution of military-technical problems by the electronics industry will be accomplished as a component part of implementation of the results of basic and practical research by planning and development of the military-technical component base as development work continues by the General Client on the concepts of development of military and military-technical goods and the corresponding investment policy in the development of the "Principal Concepts of the Military Doctrine of the Russian Federation," approved by presidential decree No 1933 dated 2 November 1993.

The Russian State Program for the Development of Electronics Technology will support those research efforts which create and further develop scientific development work in fields ensuring arrival at a fundamentally new qualitative level in the development of electronics technology.

Basic and Practical Research

Field of scientific-technical research	Content, technical specifications	Results and further applications in scientific research and design work
1	2	3
Microelectronics		
Physical-technologic processes of defect-free submicron technology for VLSI chips with design norms 0.5-0.3 μm	Development of VLSI chip technology at 0.8 μm level and special-order VLSI chips at level 0.5 μm for production of VLSI chips of type with additional memory 16-64 Mbit. Development of UV lithography projection processes (UV stepper) at level 0.3-0.5 μm. Development of technologic processes for submicron (up to 0.1 μm) and nanometer structuring, including with use of STM microscope.	Realization of highly efficient processes of through technological cycle for technology 0.3-0.5 μm for use in VLSI chip technology. Mathematical simulation programs for processes in defect-free submicron technology and research in metrology field.
Highly efficient instruments and component base applying new work principles fabricated by use of submicron technology (VLSI chips, PLIS, ADC, EN memory, etc.)	Development of highly productive component base using technology at 0.8 μm level for fifth-generation computers. Development of ultrahigh-speed belt process for data processing with audio frequencies up to 250 MHz and record peak productivities. Increase in degree of integration of semi-special order ultrahigh-speed circuits up to 10^5 per crystal. Increase in audio frequency of digital IC to 10 GHz.	Conducting complex of architectural-circuitry engineering research for realization of component base for technology at level 0.5 μm. Mathematical simulation programs for information systems for transmission of data and component base. Development of computer systems for ultraproductive computations using transputer and RISC architectures.
Semiconductor Discrete Instruments		
Promising transistor structures and instruments based on them using silicon and A^3B^5 technologies and photosensitive instruments with charge transfer.	Development of methods, designs and technologies for fabricating instruments for frequency range 10-1,000 GHz using resonance tunneling effect and instruments with increased power based on functional combining of bipolar and MOS transistors, development of multielement (up to 10^8 ultrahigh-speed photosensitive instruments operating in UV, visible and IR ranges.	Scientific-technical production unit producing competitive items and ensuring a high level of development work in microwave electronics and optoelectronics. Program packages for mathematical simulation of characteristics of elements and technology.
Incoherent optoelectronics instruments, new-generation diodes, functional semiconductor instruments and IC.	Development of photodiodes and photosensitive IC with avalanche multiplication in visible and IR spectral ranges on basis of A^3B^5 and "silicon on sapphire" connections, development of diodes based on new rectification principles in multilayer heteroepitaxial structures, mixers for wide-band devices, functional devices for high-speed signal processing in real time.	Scientific-technical production unit for developing competitive optoelectronic equipment for processing and display of information flows in economy-oriented equipment with use in communication, sounding and space systems.
Electronic Technology Materials		
Promising materials and processes for microelectronics based on A^3B^5, silicon and polymer materials	Development of materials for submicron technology for backings with a diameter 150 mm, sensitivity of UV resists up to 20 mJ/cm^2. Obtaining dislocation-free gallium arsenide on silicon	Scientific-technical production unit for developing theoretical principles of highly productive methods for performing operations in submicron technology in stages of obtaining materials and developing functional layers of VLSI chips, microwave and optical-range devices
Magnetic materials for functional devices	Development of new generation of materials for noninteracting optomagnetic devices in ranges 2.5-1.6 μm	
Superconducting high-temperature (HTSC) materials for microelectronics.	Development of epitaxial structures of HTSC materials within framework of an integrated technology for developing functional hybrid microwave circuits, photodetecting circuits, low-noise amplifying circuits, magnetometric squids with record energy resolution.	Scientific-technical production unit for complex solution of problems in use of high-temperature superconductivity in electronics.
Special materials of passive and functional electronic components, metallic film and microcomposition resistors, ceramic and film capacitors	Miniaturization to 1 x 0.5 mm^2, increase in specific characteristics up to 0.5 F/cm^3, 130 μC/cm^3, time 0.01-0.001 percent and temperature +/-(1-5) x 10^{-6} K^{-1} stability of precision resistors; switching items with 100 percent utilization factor.	Scientific-technical production unit for supplying wide range of electronic radio equipment.

Field of scientific-technical research	Content, technical specifications	Results and further applications in scientific research and design work
1	2	3
Quantum Electronics		
Efficient solid-state fiber, gas-discharge semiconductor lasers and devices based on them.	Development of efficient (35-40 percent) solid-state lasers with pulse power up to 1 J, including fiber lasers and those based on new active materials. Increase in efficiency of injection lasers to 65 percent, development of semiconductor lasers operating in visible spectral range 0.4-0.55 μm. Development of gas-discharge lasers with power density parameters up to 10^{12} W/cm^2, power up to 500 W in spectral range 5.0 μm.	Finalized scientific-technical production unit making it possible to generate sources of UV, visible and IR coherent radiation with high operational characteristics. A decrease in weight and size indices of traditional lasers by a factor of 2-3, power increase by a factor of 1.5, useful life by a factor of 3.
Information Display Devices		
New-generation high information-conveying full-color matrix LC and gas-discharge screens, electron beam converters with low-voltage excitation.	Development of new principles for production of information display devices with information content 4,000 x 4,000 elements, brightness in white light 1,000 kd/m^2. Production of screen with diagonal measuring up to 10 m. Development of technology for solid-phase recrystallization of amorphous silicon for thin-film microcircuits with number of channels greater than 40.	Finalized scientific-technical production unit developing latest technologies for high information-conveying matrix screens in a unified technologic cycle and TVF screens

Synchrotron as Experimental and Technological Basis for Conducting Basic and Practical Research in Micro- and Nanoelectronics

N. S. Samsonov, doctor of technical sciences, professor

The State Program for the Development of Electronics Technology in Russia provides for a search for priority directions in electronics on the basis of basic studies of media and phenomena, accompanied by data processing. As a rule all this research involves ultra-small-dimensional solid-state bodies measuring fractions of millimeters (as small as 0.1 μm and even the atom-molecule level) and having not only macroscopic, but also quantum properties.

Since the "Directions in Basic and Practical Research" adopted in the Program assume the obtaining of universal results at the world level, such directions require fundamental changes in traditional methodologic approaches to their formulation and investigation on the basis of new experimental apparatus.

Qualitatively new possibilities for carrying out experiments in electronics are associated with invention of the tunnel and atomic force microscopes, broadening the limits of spectroscopic equipment, mastery of methods for the generation of electromagnetic oscillations up to the gamma-X-ray range, as well as the availability of high-speed information computer systems ensuring the registry of results in the course of experiments.

With respect to the complexity of the experimental equipment and scales of material expenditures it is possible to discriminate high-energy sources of gamma-X-ray oscillations, among which with respect to the totality of indices (energy, continuous spectrum, spatial localization, stability and universality) priority must be given to synchrotrons. The merits of the synchrotron are also determined by the possibilities of its use for industrial purposes in submicron technology, in the solution of many problems in technical and medical diagnosis and in pharmacology.

What has been stated above confirms the decisions made earlier to establish a scientific-production complex on the basis of a synchrotron linked to the analytic research center and computers of different classes ensuring the simultaneous conducting of mathematical simulation (computer experiment) and subnanomicron technology.

Makeup and Characteristics of Synchrotron

The synchrotron is a high-energy electronic device in which charged particles move with relativistic velocities along trajectories curved by means of magnetic systems. As a result, synchrotron radiation arises in a broad range of electromagnetic oscillations.

The synchrotron includes:

- an injector (linear accelerator with an energy 80-100 MeV);
- booster (small accumulation ring for electrons with an energy 0.45 GeV);
- large accumulation ring for electrons with an energy up to 2.5 GeV with a mean current up to 300 mA;
- 37 channels for the output of synchrotron radiation for research, technologic and diagnostic purposes.

The principal characteristics of a synchrotron are:

- radiation range from IR wavelengths to 0.1 nm;
- diameter of large electron ring 36.8 m;
- lifetime of electron beam after injection 5 hours.

A synchrotron with the above-mentioned parameters is optimum for the purposes of debugging the technology (for example, X-ray lithography at submicron scales), diagnosis and research in field of micro- and nanoelectronics.

Synchrotron radiation (SR) has a set of unique properties, specifically:

- it is virtually the sole source having a considerable intensity and continuous spectrum from the infrared to the X-ray spectral region with a well-known degree of polarization whose spectral and angular distribution can be computed;
- it makes it possible to use built-in generation devices for increasing the spectral brightness of radiation by several orders of magnitude and to make it higher-energy;
- it is virtually the sole source of X-radiation which is adjustable in wavelength (energy);
- it ensures the acute directivity of SR necessary for experiments over a great distance from the source in the zone of low radiation danger, with division of radiation among users in the channels for SR output;
- small effective size of source and great distance to the investigated object, which ensures a high coherence and spatial resolution;
- allows time modulation of SR, which makes it possible to carry out time-resolving experiments in a strobing mode.

The layout of the synchrotron-based scientific-production complex is shown in Fig. 1, and the external appearance of the buildings is shown in Fig. 2.

X-Ray Lithography in SR Beams for VLSI and Super SLSI Chips

The formation of submicron elements of VLSI chips is extremely promising by the X-ray lithography method in SR beams. The types and characteristics of high-level lithographies are indicated in the following table:

Types and Characteristics of High-Level Lithographies

Types of lithography	Wavelength, λ, nm	Exposure area	Resolution, R, μm	Productivity, plates/hour (diameter 125 mm)	Industrial application
Electron beam	0.1	5 x 5 mm^2	0.1	1-5	yes
X-ray lithography	0.1-1.0	100 cm^2	0.5	5	yes
X-ray lithography in SR beams	0.5-10.0	1,000 cm^2	0.1	40	no (except US and Japan)
Ion lithography	0.1-0.5	1 x 1 mm^2	0.5	10	no

The X-ray lithography process, carried out in the accumulation rings with a high resolution is less expensive than cathode-ray lithography by means of which only X-ray templates are fabricated.

Research in the field of X-ray lithography has been carried out in the following directions:

- tests of different X-ray resists for the purpose of detecting highly sensitive compositions in combination with well-masking properties;
- testing of X-ray templates using different membranes;
- debugging of the technology for the application and development of X-ray resists and exposure technology for the purpose of obtaining an X-ray resist mask with submicron scales of the elements.

To carry out this work, an experimental copy of the EM-503OE matching and multiplication apparatus was developed and fabricated (Planar Scientific Production Association, Minsk). This ensures the matching of two layers with an error +/-0.05 μm.

Some of the X-ray lithographic studies have been carried out with specialists of the Physics Institute RAS. Resist masks of 0.3-0.5 μm in an area 10 x 10 mm^2 were obtained with a dispersion of size over the area of +0.1 μm (Fig. 3).

The light modification method was used for obtaining the vertical development profile. In this method the UV-light processing of the resist mask exposed to SR makes it possible to reduce the exposure energy dose by almost half in comparison with the standard dose. Thus, deviation of size over great exposure areas was precluded (Fig. 4).

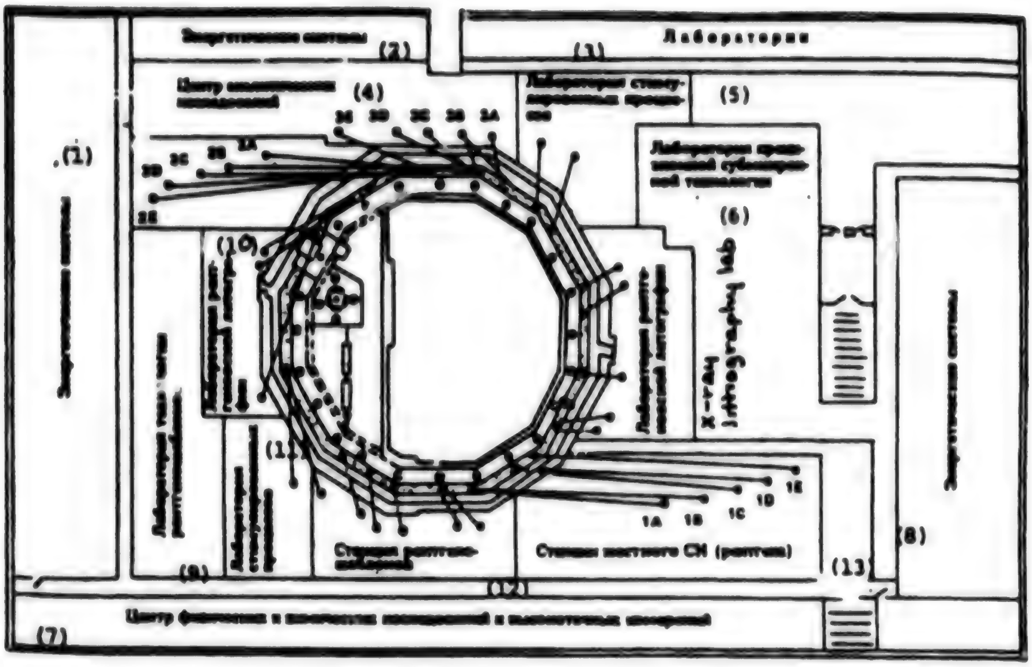


Рис.1. План научно-производственного комплекса на базе синхротрона

Fig. 1. Layout of synchrotron-based scientific production complex.

KEY:—1. Power systems —2. Laboratories —3. Analytic research center —4. Stimulated processes laboratory —5. Precision submicron technology laboratory —6. Power systems —7. Center for physical and chemical research and highly precise measurements —8. Power systems —9. X-ray board technology laboratory —10. X-ray lithography laboratory —11. Stimulated processes laboratory —12. X-ray boards station —13. Hard SR (X-ray) station

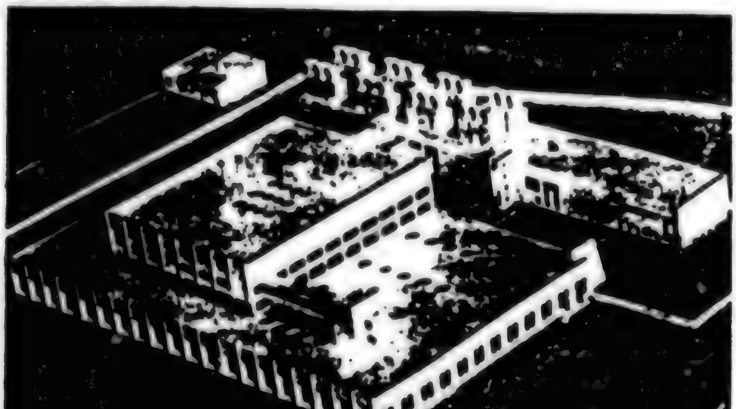
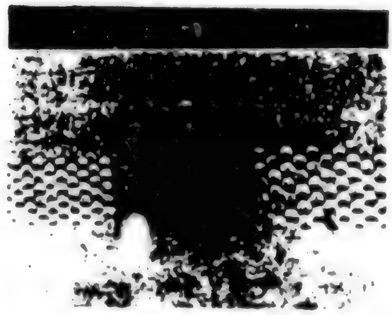


Рис.2. Научно-производственный комплекс (общий вид)

Fig. 2. Scientific production complex (general view)

a



б

Рис.3. Микрофотографии резистной маски: а — позитивной, б — негативной

Fig. 3. Microphotographs of resist mask: a) positive; b) negative

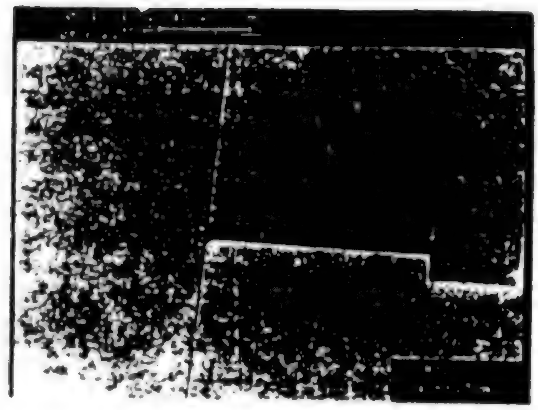


Рис.4. Микрофотографии резистной маски, подвергнутой модификации

Fig. 4. Microphotographs of resist mask subjected to modification

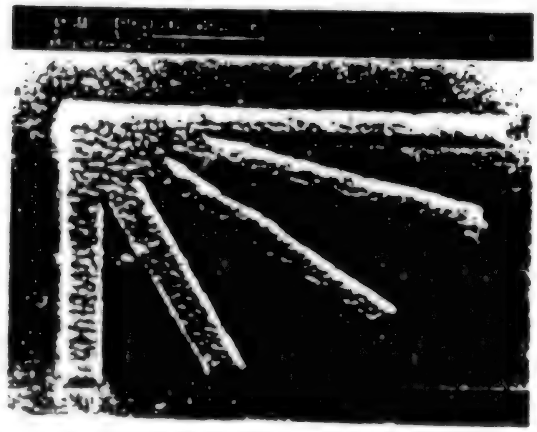


Рис.5. Фрагмент золотой маски тиражированного шаблона

Fig. 5. Fragment of gold mask of printed board ????

Our specialists carried out an X-ray lithography work program using the "ADONE" accumulation ring (National Nuclear Physics Institute, Frascati, Italy). In particular, a study was made of the process of reproducing X-ray templates, which involves obtaining prints of the latent image by the X-ray lithography method in SR beams on membrane X-ray template blanks from a completely finalized X-ray template, usually fabricated using cathode-ray lithography. A gold mask is grown after developing the print on a membrane blank by the electrochemistry method.

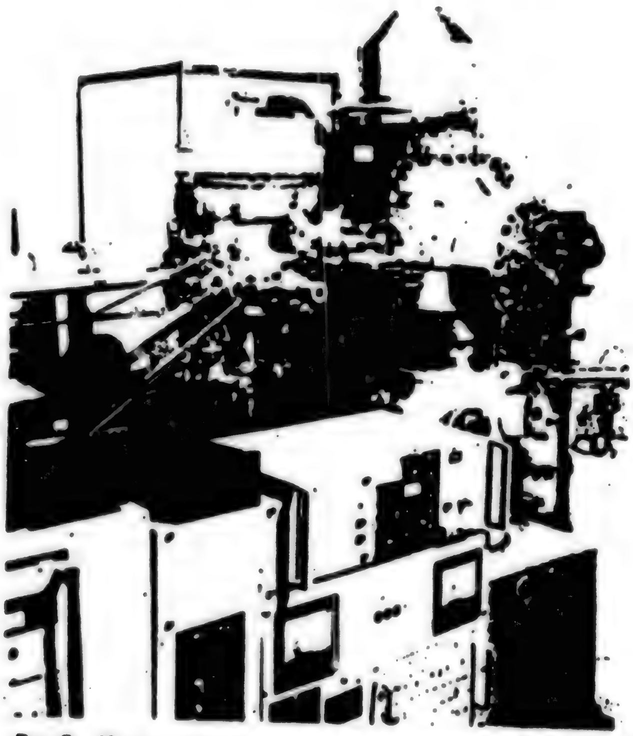


Рис.6. Исследовательско-технологическая двухмодульная установка фотостимулированных процессов и рентгеновской фотоспектроскопии

Fig. 6. Research-technologic two-module outfit for photostimulated processes and X-ray photospectroscopy

The working X-ray templates obtained by this method with a high quality and short time for obtaining a topologic pattern have a far lower cost. To carry out this work the Physical Problems Scientific Research Institute first prepared different types of membranes (for the most part Si and Si + PI) on silicon control rings for subsequent transfer of a pattern from a standard X-ray template onto them.

The standard used for reproduction was a test X-ray template fabricated at the Fraunhofer Institute (Germany). The topology of the X-ray template consisted of a set of test elements of a different configurationn and size having both a negative and positive image. The pattern was formed in a gold masking layer with a thickness 1 μm on a silicon membrane with a thickness 2 μm. The photographs obtained with a scanning electron microscope revealed the results of electrolytic precipitation of the gold masking layer (Fig. 5).

The prospects for the development of X-ray lithography and the methods involved in it involve the startup of a scientific production complex whose parameters will make it possible to carry out the following work:

1. In the field of submicron technology of ULSI and SLSI chips — the formation of elements with a scale 0.15-0.25 μm and debugging of nanotechnology elements.

2. The formation of a pattern in X-ray resists of a great thickness (100 μm) is becoming possible in micromechanics.

3. The reproduction technology will make it possible to obtain inexpensive X-ray templates and X-ray optics items, such as diffraction gratings, including freely suspended, with submicron elements.

4. X-ray microscopy in SR beams may prove to be promising. It will make it possible to analyze biological objects having a weak contrast in in vivo research by optical and electron microscopy methods. The image contrast obtained with exposure of the object to X-radiation caused by the strong dependence of transmission on object thickness and its elemental composition with a corresponding choice of the spectral range of the radiation.

The use of X-ray resists as a registry medium will make it possible to obtain an image with a high spatial resolution.

In order to solve the indicated problems it is necessary to continue research in the field of development of highly sensitive X-ray resists and high-quality X-ray templates, as well as in the X-ray lithography technology. The X-ray lithographic channels for the output of SR must be outfitted with means for constant checking on the spectral-energy characteristics of radiation, matching and multiplication devices with vertical drawing-out of the image. It also is necessary to develop some special technologic equipment (apparatus for modification, applying and development of X-ray resists).

Stimulated SR Processes of Formation of IC Elements

In submicron and nanotechnology stimulated SR processes for the formation of elements and functional layers (FL) of ULSI, SLSI and other electronic equipment items are quite promising because they ensure:

- a low temperature,
- a high selectivity and anisotropy of etching,
- high (at the monolayer level) precision of growth,
- absence of radiation defects.

The realization of these technologic advantages is possible when manufacturing equipment making it possible to integrate a number of processes in space and time for the purpose of eliminating a contact between the IC and the operator and the ambient medium, assurance of full automation of the technologic process and monitoring the parameters of the FL.

Tasks	Technologic level
1. Integration of surface cleanness solid-state processes to atomic degree of purity with precipitation of FL for submicron and nanotechnology	Density of surface states $<10^{10}$ cm^{-2} eV^{-1}; Breakdown fields >5 x 10^6V x cm^{-1}; Temperature of processes <300°C
2. Formation of multilayer quantum and heterostructures for X-ray optics and nanoelectronics	Precision - monolayer (2-5 A)
3. Synthesis of new materials. Development of technology and items in "diamond" electronics	Working temperature <400°C. Resistance to radiation: to neutrons 10^{14} cm^{-2} to roentgen 10^{16} cm^{-2}

The SR spectral range of the Zelenograd Technical-Scientific Complex covers the entire range of quanta required for activation of reagents and is capable of ensuring a technology with nondestructive precision methods for checking the quality of technologic operations and the FL in situ.

The technologic processes stimulated in the soft X-ray (SXR) spectral range are of special interest: 1) The SR source has no equal in spectral brightness in this region. 2) The inner shells of atoms and molecules excite SXR, which accelerates the rates of photochemical reactions, affords new, still unknown channels and possibilities. 3) The excitation process occurs on the surface in adsorbed layers and in depth only affects several atomic layers (due to the high absorption coefficient 10^6 cm^{-1}, which ensures precision in surface processing at the monolayer level without the introduction of radiation damage, not attainable by other methods.

The following tasks can be formulated and solved by radiation-stimulated technology using an SR source:

For advance in this direction, in collaboration with the Moscow Engineering Physics Institute, we constructed a 2-module research-technologic apparatus with autonomous sources of stimulating UV and VUV radiation and X-ray radiation for RFS surface analysis (Fig. 6). The following table gives the characteristics of sources of UV and VUV radiation:

Sources of UV and VUV

Type of source	Intensity, W/cm^2	Irradiated area, cm^2	Spectral range, nm	Uniformity of irradiation, percent
SR from ondulator*	0.1**	1	30-3000	50
SR from wiegler	0.01**	5	30-3000	50
SR from rotating magnet	0.001**	5	30-3000	10

Type of source	Intensity, W/cm^2	Irradiated area, cm^2	Spectral range, nm	Uniformity of irradiation, percent
Excimer lasers	0.5#	2	157	10
	20#	2	193	10
	50#	2	248	10
	30#	2	308	10
Gas discharge tubes				
(resonance)	0.1	10#	123.6	10
(resonance)	0.1	10#	147	10
(resonance)	0.1	10#	160	10
(low pressure)	0.1	10#	184.5; 267	10

*Indicates Zelenograd specialized SR source

**Indicated in interval $\Delta\lambda/\lambda$ = 100 nm

Note: The # symbol indicates quality

Apparatus parameters: Technologic module: residual pressure 5 x 10^{-6} Pa, working pressure up to 10^4 Pa, backing temperature 160+300°C

Source of stimulating radiation: low-pressure mercury lamp λ_1 = 185 nm, Q_1 = 2 mW x cm^{-2}, λ_2 = 254 nm, Q_2 = 20 mW x cm^{-2} krypton pulsed lamp λ = 147 nm, Q = 1 mW x cm^{-2}, gas system: O_2, HF_3, SiH_4, SiH_6 quadrupole mass spectrometer at 1...100 amu.

Analytic module: source of X-radiation $Al_{k\alpha}/Mg_{k\alpha}$, intensity of X-ray source up to 300 W, working pressure 5 x 10^{-8} Pa, intensity $Ag3d_{5/2}$ of peak with width 1 eV...10^5 pulses/s, type of electron analyzer — hemispherical.

This apparatus was used in studying the integral technologic process of photochemical purification of silicon backings from organic contaminants with subsequent precipitation of silicon dioxide films at a temperature 200°C.

The parameters of the films are comparable to a thermal oxyl: thickness (20-50) nm; density 2.2 g x cm^{-3}; refractive index 1.456; stoichiometry N_O/N_{Si} = 2+0.1; density of surface states 10^{11} cm^{-2} eV^{-1}; electric breakdown field 5 x 10^6 V x cm^{-1}.

The results in a rather narrow region of stimulating radiation convincingly indicate the good prospects of use of SR for solving basic problems in modern micro- and nanoelectronics.

Abroad (primarily in Japan at the photon plant at Tsukubi) vigorous research and development is being carried out on the use of SR in ULSI and nanoelectronics technology.

In order to realize the possibilities of SR in ULSI and SLSI chip technology it is proposed that a multimodule station using 3 SR output channels be set up at the Zelenograd Scientific Production Complex. This will require not only the development of specialized high-vacuum equipment replete with modern diagnostic tools, but also high-vacuum channels for the conveyance of SR to the station, supplied with monochromators operating in the spectral range from the soft X-ray to the UV.

Use of SR in Analytic Research

The development of VLSI, SSSI and ULSI chips requires conducting research on technologic processes using silicon and other materials when obtaining submicron sizes. There is a sharp increase in the percentage of research and control of the parameters of structures using new precision analytic research methods determined by the physical and chemical properties of surfaces and interfaces.

The complexity and diversity of the problems to be solved require a many-sided approach to their solution, which is achieved by the broad use of synchrotron radiation (SR).

One of the ways which will make possible a many-sided approach to solution of difficult problems in microelectronics is the setting up of an SR analytic center at the Zelenograd Scientific Production Complex. Within the capabilities of such an SR center it is possible to apply a number of new unique methods for the diagnosis and checking of materials and functional layers and films used in the process of producing VLSI and super LSI

chips so that it will then be possible to proceed to controlled production processes. For example, the express topography method in the continuous SR spectrum will ensure 100 percent control of the plates (analysis of the state of general structural perfection and presence of defects in monocrystals) in several seconds. Control methods with such measurement times do not presently exist. The X-ray topography method in monochromatic radiation in SR beams will ensure 100 percent analysis of silicon plates in initial and operation-by-operation control (analysis of defects initiated with different disturbances in the technologic process) during an exposure time of several minutes in comparison with tens of hours when using X-ray tubes.

These methods must be actively used in research and development work on technologic processes for the production of VLSI and SLSI chips making use of promising new materials in microelectronics.

When studying the principles of functioning and also ways to develop quantum electronic instruments on the basis of quantum nanoelectronics it is particularly important to use the following research methods in SR beams:

- photoelectronic spectroscopy in polarized beams of SR, which ensures study of the band, electronic and geometric structure of surfaces and adsorbed layers with a thickness from a monatomic layer or more;
- analysis of an extended fine structure of the X-ray absorption spectra in SR beams, which will ensure investigation of the structure of heterogeneous systems, disordered and transient layers and will make it possible to make measurements in tens of minutes instead of days and weeks when using X-ray tubes;
- X-ray fluorescent analysis in SR beams, which will ensure rapid checking of the elemental composition of materials and structures, as well as technologic media, with a minimum analysis time of not more than tens of seconds.

The development of equipment and basic technologic processes in the production of integrated circuits on the basis of HTSC also requires active use of other unique research methods in SR beams:

- the method of high-resolution X-ray topography in SR beams ensures checking of microdefects in the presence in the initial plates during an exposure time of several minutes in comparison with tens of hours when using X-ray tubes with a comparable resolution;
- the method of diffraction nondestructive examination beams of the surface structure and interfaces in the processes of growth and precipitation of functional layers and films ensures investigation of the atomic structure of the surface, interfaces and adsorbed layers, thickness of deformed and transition layers, profile of distribution of admixtures with a degree of expression exceeding the possibility of known methods by a factor of 1-100;
- the X-ray analysis method ensures investigation of an atomic-crystalline structure (of a near and distant order) of ultradispersed amorphous crystalline materials, organic and elementoorganic substances in a condensed state and makes it possible, in combination with modern computer methods for the processing of structural information, to reduce the time for determining structurally complex crystalline objects by a factor of approximately 10^2-10^3;
- the X-ray-phase analysis method ensures the conducting of phase analysis of microcomponent structures with a speed greater by a factor of 10^2-10^3 and with an angular resolution of the diffraction lines greater by a factor of 5-10 than in ordinary phase analysis methods.

Thus, the development of new semiconductor and optoelectronic instruments will require use of the entire complex of analytic research methods using SR beams.

SR is now being actively used by the world's leading companies in microelectronics in the development of electronic and optoelectronic instruments. In Japan alone there are now more than 20 specialized sources of SR in such companies as NTT, Hitachi, Soptec, NEC, etc. These companies are carrying out research in the field of X-ray lithography, radiation-stimulated processes, study of new materials and medicine. Their purpose is to attain a fundamental understanding of the processes transpiring in semiconductor instruments and also the development of new technologic processes.

Recently the State Physical Problems Scientific Research Institute has been developing new unique methods for X-ray-magnetooptic studies of amorphous and crystalline (including new ones synthesized by molecular beam epitaxy methods) materials and structures making it possible to ensure precision diagnosis of functional layers of instruments developed by nanotechnology methods: X-ray template membranes and wide-purpose transducers, ultrahigh-speed transistors, carbon films for modifying the surfaces of blood-compatible implants, multilayer magnetic structures for data readout heads, etc. These instruments and structures are finding broad application in military technology, medicine and the economy.

The development of methods for the control of the characteristics of X-radiation will ensure simplification and cost reduction in the diagnosis of functional layers in the stage of instrument manufacture.

Thus, the synchrotron-based production complex can ensure implementation of basic and practical research in the field of micro- and nanoelectronics provided for in the State Program for the Development of Electronics Technology in Russia. Thereby a solution is found for the problems involved in the development of ultralarge ULSI and SLSI chips with topologic scales up to 0.1 μm with a speed in the picosecond range per element, and it will be possible to accomplish the laying out of circuitry and design-technologic debugging of the technology for instruments in quantum microelectronics, being one of the principal directions in solving the "speed-degree of integration" problem. According to predictions of foreign scientists, this problem will be timely to the end of this century.

The starting up of the scientific-production complex at Zelenograd, unique for the entire electronics industry, will make it possible not only to develop the industrial basis for a new components base of micro-and nanoelectronics, but also to carry out research on development of micromechanical items on the basis of microelectronic technology, affording fundamentally new possibilities for manufacture of electromechanical equipment and systems for scientific, technical and medical purposes. On the basis of the Zelenograd Scientific Production Complex it seems desirable to create a service for the diagnosis, quality control and certification of materials, micro- and nanostructures. Paid-for filling of orders for diagnosis and certification is economically desirable (according to foreign data, 1 hour of use of one synchrotron channel is priced at 500 dollars).

The multifunctional possibilities of the synchrotron-based complex will make possible its use not only for the purposes of electronics, but also in such important fields as pharmacology, biomedical research and practical public health.

Project. Use of Synchrotron Radiation in Microelectronics. Establishing a Synchrotron-Based Scientific-Production Facility

Conducting research for the development of technology (X-ray lithography and radiation-stimulated processes and diagnosis of structures with topologic size up to 0.1 μm).

Carrying out basic research for studying ways to develop a new component base for micro- and nanoelectronics for solving the "speed-degree of integration" contradiction (solution of problems in quantum microelectronics and development of instruments for tunnel-resonance and other physical effects).

Technical Specifications

Injector (linear accelerator with an energy 80-100 MeV).

Small accumulation ring for electrons with energy 0.45 GeV.

Large accumulation ring for electrons with energy up to 2.5 GeV.

37 channels for the output of synchrotron radiation for research, technologic and diagnostic purposes.

Radiation range from IR to 0.1 nm.

Exposure area 10 x 10 cm^2.

Diameter of large electron ring 36.8 m.

The cost of such a Synchrotron Center with analytic equipment is about 150 million dollars. A high percentage of the expenditures on the Zelenograd Center have already been made.

Work To Be Done Within Scope of Project

- At Zelenograd, complete the construction and startup of a synchrotron-based facility, including analytic equipment and automated data processing systems.
- Development of technologic processes and diagnostic methods and the equipment necessary for them.
- Fabrication of copies of new microelectronic instruments with topologic size 0.3-0.1 μm and a speed in the picosecond range per unit.
- Organization of a center for biomedical research.
- Organization for meeting the needs of industrial enterprises of a service for the diagnosis, quality control and certification of materials, micro- and nanostructures on a profit and loss basis.

Times and Volumes

1994-1995 — perfection of technologic processes and diagnostic methods and development of research equipment.

1996-1997 — basic research on quantum microelectronics structures (topologic size up to 0.3-0.1 μm or less).

1998-2000 — conducting of research for study of properties of nanoelectronic instruments, their transfer to an industrial basis, as well as practical use of a multifunctional synchrotron-based facility.

Funding and Cost Recovery Period

The approximate amount of investment required during 1995-1997 for ensuring effective operation of the center must be about 250,000 dollars annually.

The recovery of costs will be governed by the new scientific results obtained in the interests of development of Russian micro- and nanoelectronics, as well as the filling of paid-for orders. The cost of one hour of use of one synchron channel is now estimated at about 500,000 dollars.

Physical Problems State Scientific Research Institute
Telephone: (095) 531-46-56

Foundation for Development of Electronics Technology — Exceptionally Pure Materials

B. G. Gribov, doctor of chemical sciences, professor, corresponding member Russian Academy of Sciences

The Russian State Program for the Development of Electronics Technology provides for the development and organization of the production of semiconductor and exceptionally pure materials — those which are the very basis of the component base of microelectronics.

In contrast to the preceding periods of development in this field, this program does not set the goal of development and production of all the materials required for the production of IC in Russia.

The Program for the development of Electronics Technology includes a broad range of materials intended for the development of 29 fields of instrument and material science, which incorporates more than 400 special fields and about 3,000 types of instruments and materials for microelectronics, optoelectronic display and data processing devices, cathode-ray instruments and matrix liquid-crystal screens; household VCRs, UHF instruments, photoconverters, optical multiplication systems, quantum electronics instruments; solid-state lasers; piezoconverters, resistors, capacitors, radio components, ferrite items, etc.

At present, due to the entry of Russia into the international market, it is more convenient and economically advantageous to import from abroad materials that are needed in small quantities while producing in great quantities other materials that careful study and evaluation of the consumer market tells are in demand in our own country and abroad, especially in Europe. Such an approach eliminates the need to invest considerable state budgeted sums in implementation of programs to develop, master and organize production of all materials to replace imports without exception.

We feel that it is first necessary to obtain funding for development work on the following materials having multibranch, branch and also dual-purpose (civilian and military) use, in whose acquisition different companies are interested, for maintaining quality and competitiveness in the world market:

- semiconductor materials, including initial raw material;
- resists and template blanks for lithographic processes;
- liquid-crystalline materials;
- exceptionally pure liquid-phase, gaseous and solid materials and substances;
- exceptionally pure isotropic fine-grained graphite, exceptionally pure silicon carbide and technologic fittings based on them;
- filtration materials and filtering devices;
- metals and alloys of exceptional purity and targets based on them;
- polymer materials, including for the sealing of electronic equipment items.

Russia has highly trained personnel, a considerable backlog of scientific work, production facilities and power supplies. But the lack of the necessary special technologic equipment, analytic and control-measuring equipment and worn-out technology is holding back the production of the most important raw materials.

In this case it is economically more advantageous to organize, with any interested European company, joint production in the work areas of Russian enterprises or to examine the problem of the sale of know-how, for example, in such fields as resists, graphite and silicon carbide of exceptional purity, highly pure metals, quartz of exceptional purity and items based on them; molding materials for the sealing of integrated circuits and semiconductor instruments.

Much scientific potential has been accumulated in Russia as a result of the successful conducting of basic and practical research by the State Administration for the Electronics Industry in collaboration with organizations of the Russian Academy of Sciences and the Ministry of Science and Technical Policy, and patentable products have been obtained. However, for developing technology and the corresponding production facilities there must be considerable financial investment, estimated in the hundreds of millions of dollars. Among such fields it is possible to include the technology of superlattices, nanotechnology, ash-gel technology and the centrifugal technology for the separation of isotopes applicable for the purification of hybrid gases; attainments in the field of semiconductor compounds of the A_2B_6 type, methodologic and instrumental development work in supporting

quality control and certification in conformity to international standards for exceptionally pure materials.

Project. Monosilane

Development of a technology for the industrial production of especially pure monosilane.

Monosilane is the initial material for the growing of silicon monocrystals and also for the formation of different technologic layers in microelectronics technology.

Monosilane is not produced in Russia. An ecologically safe technology has not been developed.

Technical Specifications

Content of basic substance, percent 99.9995

Content of impurities, ppm:

water — 1.0

oxygen — 0.5

methane — 0.1

carbon monoxide — 0.5

metals — 1.0

carbon dioxide — 0.5

Content of particles measuring up to 0.2 μm — not more than 50 units/liter Approximate price: 500 dollars/kg

Work To Be Done Within Scope of Project

- Development of technology for large-series production.
- Development and fabrication of experimental-industrial apparatus.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of monosilane can be initiated in 1996 with an increase each year:

1996 — 1 ton;

1997 — 3 tons.

Funding

The approximate amount of investment required to implement the work program is 10 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met, the investment will be fully recovered in 1997. The time for full repayment of the loan with interest is January 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Filters

Development of a technology for the production of highly productive regenerative prefilters for the fine purification of liquid and gaseous media based on porous polyvinylformaline (PPVF) with an adjustable pore form and size.

Porous polyvinylformaline has a three-dimensional open cellular structure; the pore shape and size are governed by the technologic mode for obtaining the filtering element. The filtering element block is formed with stipulated shape and size in a single technologic process. Due to its elasticity in a moist state, the material of the filtering element is easily washed out by aqueous solutions of surface-active substances and therefore can be used repeatedly.

Technical Specifications

Pore size, μm — 5-1,000

Minimum size of particles held, μm — 1-3

Porosity, percent by volume — 75-92

Water absorption (for material unprocessed with thermally reactive resin), percent by mass — 500-1,500

Apparent density, kg/m^3 — 100-300

The productivity of the filter and the degree of purification of the medium vary in a wide range, depending on porosity, pore size and thickness of the filtering layer.

One kilogram of industrial PPVF costs approximately 200 dollars. Depending on the mass of the filtering element, governed by its purpose, 5-10 filtering elements can be prepared from one kilogram of PPVF.

Work To Be Done Within Scope of Project

- Development of technology for large-series production.
- Development and fabrication of technologic fittings.
- Acquisition of technologic and test equipment.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of filters based on PPVF can be initiated in 1996 for gaseous media and beginning in 1997 for

liquid media with increases in the volume of production over the course of three years:

1996 — 10 tons;

1997 — 30 tons;

1998 — 50 tons.

Funding

The approximate amount of investment required to implement the work program is 10 million dollars. The form of funding is an advantageous 3-year loan.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest will be July 1998.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05

Project. A^3B^5 Plates and Monocrystals

Further development of technology for obtaining polycrystals, monocrystals and plates of gallium arsenide and gallium phosphide with diameter 50.8 and 76.2 mm and organization of their industrial production.

Monocrystals and plates of gallium arsenide and gallium phosphide are intended for use as substrate material in the production of light-emitting indicators, different discrete electronic equipment items and integrated circuits. It is proposed that not less than 90 percent of the production volume be exported. There is a ready market for these materials, with a capacity of up to 10 million dollars a year.

Technical Specifications

Monocrystals and plates of gallium arsenide with a diameter of 50.8 and 76.2 mm; doped with Te, Zn; orientation [100] and [111]. Price per plate about 1.2 dollars/cm^2.

Pure polycrystalline gallium arsenide. Price about 425 dollars/kg.

Gallium phosphide monocrystals and plates of gallium phosphide with a diameter 50.8 mm; doped with Te, S; orientation [111] and [100]. Price per plate about 1.5 dollars/cm^2.

Pure polycrystalline gallium phosphide. Price about 550 dollars/kg.

Work To Be Done Within Scope of Project

- Further development of technology for the industrial production of crystals and plates.
- Development and fabrication of special technologic equipment.
- Acquisition of special technological and control-measuring equipment.
- Planning and installation work for re-outfitting existing production facilities.

Times and Volumes

The increase in volumes of sales of polycrystals, monocrystals and plates of gallium arsenide and gallium phosphide by years (in millions of dollars) will be:

1994 — about 1;

1995 — about 3;

1996 — about 5;

1997 — about 7.

Funding

The approximate amount of investment required to implement the work program is 3 million dollars. The form of funding is an advantageous 3-year loan.

Cost Recovery Period

If the stipulated volumes of production are met, the full repayment of the loan may be possible during the first half of 1997.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05.

Microelectronics Technology Scientific Research Institute, Kaluga Fax: (084-22) 4-37-28.

Project. Exceptionally Pure Reagents

Development of a technology for the production of exceptionally pure liquid-phase reagents (LPR).

The developed exceptionally pure liquid-phase reagents (acids, alkalis, solvents, etc.) are widely used in microelectronics and semiconductor technology.

One of the most important stages in the technology for fabrication of VLSI chips is chemical processing, preceded by many technologic operations in the production of microcircuits (diffusion, oxidation, precipitation of layers, microlithography, etc.). Sensitivity to the purity of reagents and technological media, especially the presence in them of metallic impurities and suspended particles, increases with an increase in the degree of

integration of microcircuits and exerts a substantial influence on the yield of finished items, on quality and reliability.

Technical Specifications

Limited content of microimpurities (for 30-40 impurities), percent by weight

Content of microparticles measuring 0.1 μm, particles/cm^3 — not more than 10^{-6}-10^{-8}

Work To Be Done Within Scope of Project

- Development of technology for large-series production.
- Development and fabrication of technologic fittings.
- Acquisition of technologic and measuring equipment.
- Development of special packaging for transport and storage of liquid-phase reagents of exceptional purity.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of LPR can be initiated in 1997. It is proposed that the volumes can be changed by years:

1996 — 1,000 tons

1997 — 10,000 tons.

Funding

The approximate amount of investment required to implement the work program is 2.5 billion rubles. The form of funding is an advantageous 3-year loan.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest is 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Monocrystalline Silicon

Development of a technology for the production of high-quality silicon monocrystals of the grade KEF 4.5, diameter 150 mm, mass up to 30 kg.

Monocrystalline silicon with a diameter of 150 mm with improved electrophysical parameters and structural perfection is intended for the fabrication of silicon plates used in the production of microcircuits with a memory having a capacity 1 Mbit.

Technical Specifications

Diameter, mm ... up to 150 +/- 0.5

Length, mm ... up to 800

Weight, kg ... up to 30

Sectional scatter, percent ... +/-8

Scatter for oxygen concentration, cm^{-3} ... +/-1 x 10^{17}

Carbon concentration, cm^{-3} ... <2 x 10^{16}

Density of dislocations, cm^{-2} ... not more than 10

Approximate price, 1 kg, dollars ... 150

Work To Be Done Within Scope of Project

- Development of technology for production of monocrystals with volume up to 5 tons per year per apparatus
- Acquisition of additional 4-5 apparatuses of Deymos type under load of 60 kg
- Acquisition of equipment for cutting of monocrystals with mass up to 60 kg
- Acquisition of equipment for measuring electrophysical parameters —lifetime, specific resistance
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of monosilicon grade KEF-4.5 can be initiated in 1995 and will increase by years:

1995 — 2 tons;

1996 — 5 tons;

1997 — 15 tons;

1998 — 25-30 tons

Funding

The approximate amount of required investment for implementing the work program is 6 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1998.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05

Project. Sealing Materials

Development of a technology for the fabrication of press materials for the sealing of integrated circuits and semiconductor instruments and initial substances

and intermediate products. The quality of the molding material ensures reliability of the integrated circuits and semiconductor instruments. The lack of such materials in Russia explains why over the course of almost 25 years press material and some raw material for its manufacture were purchased abroad.

Technical Specifications

Viscosity, mm ... 600-900

Hardening regime outside compression mold, hours/°C ... 2-8/165-180

Shrinkage upon hardening, percent, not more than ... 0.4

Preservation time at temperature +10°C, months... 6-12

Reworking temperature, °C ... 165-180

Vitrification point, °C, not less than ... 155

Range of working temperatures, °C ... 60 q+155

Elastic modulus with bending, MPa, not less than ... 140-160

Concentration of impurities, percent by mass, not more than:

sodium ... 5 x 10^{-4}

lithium, potassium, calcium (total scaled to sodium) ... 5 x 10^{-4}

ionic chlorine ... 5 x 10^{-4}

Thermal conductivity, W (m, °C), not less than ... 0.7

With respect to inflammability, level of residual stresses in fabricated items and corrosion passivity during testing in moist heat under pressure (121°C, 100 percent, 2 atm., 1,000 hours) it is at the level of analogues of Japanese and German companies. Approximate price — 40,000 rubles/kg.

Work To Be Done Within Scope of Project

- Development of required composition and preparation of technologic regulations for fabrication of compression mold
- Development of industrial technology for the fabrication of initial materials and finished form of compression molds
- Fabrication and acquisition of technologic and control-measuring equipment
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of compression molds wil' begin in 1996 and the planned production level will be reached in 1997:

1996 — 500 tons,

1997 —1,000 tons.

Funding

The approximate amount of required investment for implementing the work program is 10 billion rubles. The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest is 1997.

State Enterprise Electronic Materials Scientific Research Institute, Vladikavkaz Telephone: (86722) 4-81-02, 4-80-13 Teletype: 265 144 "Karbolit"

Project. Liquid Crystal Materials

Development of a technology for fabricating liquid crystal materials.

Liquid crystal materials (LCM) are used for fabricating liquid crystal indicators (LCI), constituting devices of a new generation for the display of complex information corresponding to the latest international requirements with respect to reliability, ergonomic characteristics and information saturation and ensuring comfortable conditions for the operator. It is proposed that LCM be produced by patented methods.

Technical Specifications

Range of working temperatures, °C — -20/mq +80

Switching times, ms — 40

Controlling voltages, V — 2-3

Conductivity, $ohm^{-1}cm^{-1}$ — less than 10^{-12}

Multiplexity for ultratwist LCM, not less than — 500:1

The approximate price as a function of the type of LCM is from 3,000 to 20,000 dollars per kilogram.

Work To Be Done Within Scope of Project

- Working out a technical plan for constructing a variety of types of technologic equipment
- Development of a technology for production of initial raw materials and semifinished goods

- Development of a technology for fabrication of finished forms of LC materials
- Preparations for and organization of production of LCM
- Metrologic and certification testing

Times and Volumes

The production of LCM can be initiated beginning in 1996 and will increase by years:

1996 — 500 kg;

1997 — 2,000 kg

Funding

The approximate amount of required investment for implementing the work program is 5.5 billion rubles. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest will be 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Photoresists

Development of a technology for fabrication of resists for microlithographic processes.

In Russia and the CIS countries there is no production of resists for performance of microlithographic processes in the fabrication of VLSI chips. The requirements are therefore met by purchases from abroad.

Technical Specifications

Photoresist:

film thickness, μm — 1.3-1.8

photosensitivity, mJ/cm^2 — 50-80

resolution, μm — 0.8

mask linearity, μm — 0.9-1.5

focal depth, μm, not less than — 1

numbers of microdefects, not more than — 5 per plate

traces of metals ppm, not more than — 1

thermal resistance, °C, not less than ... 140

Electronic resist:

film thickness, μm — 0.4

resolution, μm — 0.2

contrast, not less than — 6

electronic sensitivity with electron energy 10 keV, μCl/cm^2 — 6 x 10^{-5}

plasma resistance, not less than — 2.5

Electronic resist with chemical amplification:

film thickness, μm — 0.3-1

resolution, μm — 0.5-0.3

contrast — 3

sensitivity, μCl/cm^2 — 0.5-5

plasma resistance — 2-2.5

thermal resistance of protective relief — -140-200°C

Approximate price: 90-170 dollars/kg

Work To Be Done Within Scope of Project

- Development and construction of experimental lines, including organization of clean rooms
- Development of new technologies for fabrication of resists
- Development of a technology for fabrication of initial products
- Development of a technology for fabrication of processing solutions
- Fabrication and acquisition of technologic and control-measuring equipment
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of resists can be initiated in 1997 and the planned production will be reached in 1998:

1997 — 5 tons;

1998 — 40-50 tons.

Funding

The approximate amount of required investment for implementing the work program is 6 billion rubles. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest is the first half of 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Targets

Development of a technology for obtaining sprayed targets from metals and alloys of a high purity and also ceramic materials (nitrides and oxides) and the organization of industrial production of targets.

The developed targets are intended for use in equipment for spraying of the magnetron, arc and other types for application of conductive, reflecting, adhesive, protective, wear-resistant and decorative coatings.

Technical Specifications

Purity of targets (percent by mass)

metals with high melting point

chromium ... 99.99-99.995

titanium ... 99.95-99.99

ceramic materials

(Al, Ti nitrides; Zn, Zr and other oxides — 99.0-99.9

magneto-optical materials ... 99.0

Geometric dimensions (maximum, mm):

length ... 500

width ... 120

thickness ... 12

The approximate price per item is from 300,000 to 1 million rubles.

Work To Be Done Within Scope of Project

- Development of technology for obtaining high-purity raw material for production of targets
- Development of a technology for fabrication of sprayed targets
- Development and fabrication of technologic fittings
- Acquisition of technologic and control-measuring equipment
- Preparation of industrial production of targets for spraying

Times and Volumes

The approximate need for these materials is (units):

1995 — 250;

1996 — 500;

1997 — 900;

1998 — 1,800

Funding and Cost Recovery Period

The approximate amount of required investment for implementing the work program is 600 million rubles. The form of funding is an advantageous loan for 3 years.

The time for recovery of costs will be 1 year after work completion. The loan will be repaid in 1997.

Exceptionally Pure Materials Scientific Research institute, Zelenograd Fax: (095) 531-70-95

Project. Graphite

Development of a technology for the fabrication of technologic fittings on basis of fine-grained isotropic graphite (FGIG) of an exceptional purity. Fine-grained isotropic graphite is a unique construction material for the electronics and electrical engineering industries and aerospace construction. In Russia and the CIS countries none is produced, and the need is covered by imports.

Technical Specifications

Fine-grained isotropic graphite

	FGIG-1	FGIG-2	FGIG-7
Apparent density, kg/m^3, not less than	1,750	1,780	1,700
Compressive strength, MPa, not less than	50	70	80
Bending strength, MPa, not less than	25	35	35
Thermal expansion coefficient, 10^{-6}/K	4.9	4.8	6.5
Resistivity, μohm/m	12	15	18
Grain size (predominant), μm	50	20	15

Size of blanks:

a) diameter, mm, more than ... 320

height, mm, more than 600

b) width, mm ... 450

length, mm ... 450

height, mm ... 150

The approximate price of large blanks is from 10,000 to 40,000 dollars per ton on the international market and 4-8 million rubles on the domestic market.

Work To Be Done Within Scope of Project

- Further development of the technology (more precise determination of the modes for grinding, mixing and isostatic pressing; thermal processing and thermal purification)
- Fabrication and acquisition of technologic equipment
- Conducting initial adjustment work
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of FGIG can be initiated in the first half of 1996 and will increase by years (in tons):

1996 — 100;

1997 — 300.

Funding

The approximate amount of required investment for implementing the work program is 2.05 billion rubles.

The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

If the stipulated volumes of production are met, the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest will be 1997.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Silicon Carbide

Development of a technology for the production of materials for functional and structural purposes on the basis of silicon carbide with a stipulated structure, phase composition and physical properties for the needs of high technologies.

Organization of standard production of silicon carbide materials.

Silicon carbide is a promising material.

The electrophysical properties of silicon carbide are capable of ensuring the development of solid-state instruments having thermal, chemical and radiation resistance. Due to its physicomechanical properties it is an indispensable construction material. Items (fittings) based on silicon carbide can be successfully used in different high-technology fields (laser and aerospace technology, nuclear power, electronics and radio electronics industry, etc.).

Technical Specifications

Density, g/cm^3 ... 3.2

KTLR, 1/degree, not less than ... 4.3 x 10^{-6}

Porosity, percent ... zero

Content of admixed elements, ppt, not more than ... 5

Resistivity, ohm/cm ... 1-600

Compression strength, MPa, not less than ... 1500

Resistance to thermal impact (25-1,300°C), heat cycles ... 4,500

Approximate cost of items ... 1,500-3,000 dollars.

Material based on self-binding silicon carbide of SiC-C polytype

Density, g/cm^3 ... 3.0

Elastic modulus, GPa, not less than ... 250

Thermal conductivity coefficient, W/m x degree, not less than ... 80

Microhardness of principal phase, GPa, not less than ... 30

Approximate cost of items, dollars — 100-500

Work To Be Done Within Scope of Project

- Theoretical and experimental research
- Development of industrial technology
- Development and fabrication of technologic fittings
- Acquisition of special technologic equipment
- Preparations for and organization of production
- Metrologic and certification testing
- Training of servicing personnel.

Times and Volumes

The production of silicon carbide of the type β-SiC can be initiated in 1996. The volumes of production of items by years (units) will be:

1996 — 300;

1997 — 600.

The principal consumer is the microelectronics industry.

The production of silicon carbide of the SiC-C type can be initiated in 1996.

The volumes of production of items by years (units) will be:

1996 — 2,500;

1997 — 4,000.

The principal consumers will be the electronics industry, laser and aerospace technology fields.

Funding

The approximate amount of investment required for implementing the work program is 1.7 billion rubles. The form of funding is an advantageous loan for 2 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1996. The time for full repayment of the loan with interest will be the beginning of 1997.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Blanks for Phototemplates

Development and startup of production of masked plates for precision templates on backings of quartz glass of exceptional purity. The masked plates are intended for the fabrication of the templates used in VLSI semiconductor technology. The use of synthetic exceptionally pure quartz glass as a backing with a great area and with a low thermal expansion coefficient, high transmission in a wide spectral range and a high quality with respect to defects and high wear resistance.

The backings of exceptionally pure quartz glass have substantial advantages in comparison with Russian analogues.

The proposed many-sided purposeful program provides for the development and organization of production not only of quartz glass of exceptional purity and items based on it (phototemplates, optical parts, waveguides, etc.), but also the production of phototemplate blanks of a wide variety on backings of quartz, silicon borate (or silicon phosphide) and calcareous silicate glass with parameters at the level of world standards (EMI, United States).

Technical Specifications

Size, mm — 127 x 127, 153 x 153

Thermal expansion coefficient, $°C^{-1}$ — 7.5×10^{-7}

Transmission coefficient, percent (with λ, nm) — 70 (230); 70 (254); 85 (365); 90 (405); 90 (436)

Defects of backing within limits of working zone, cm

in volume — 2 μm - 0

surface defects — 1 μm - 0

Masking layer — chromium, chromium oxide

Reflection coefficient, percent — 1-25; 25-40; 40

Work To Be Done Within Scope of Project

- Development of a technology for series production
- Development and fabrication of technologic fittings
- Acquisition of technologic and control-measuring equipment
- Development and startup of production of hydroxyl-free exceptionally pure radiation-resistant quartz glass
- Preparations for organization of production
- Metrologic and certification testing
- Organization of warranty servicing and training of users

Times and Volumes

The production of masked plates for precision templates on backings of quartz glass of exceptional purity can be initiated in 1995 and will increase by years (thousands of units):

1995 — 10;

1996 — 20;

1997 —50

Funding

The approximate amount of investment required for implementing the work program is 10 million dollars.

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of investments will be attained in 1997.

The time for full repayment of the loan with interest will be the first half of 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05.

Project. Abrasive Materials

Development of technology and organization of production of ground and polished materials (buffing wheels and bands) on the basis of a porous polyvinylformaline (PPVF) for finishing the surface of metals, alloys, glass, quartz, ceramic and semiconductor plates.

The polymer-bound abrasive material ensures a manyfold saving of expensive (especially diamond) abrasive powders in comparison with their use in the form of pastes and suspensions. In this case the quality of surface processing is considerably greater due to the elasticity of the polymer matrix, ensuring uniformity of loading of the abrasive particles and as a result, absence of local overheatings, burns and furrows on the processed surface. The presence of free pores ensures capture and removal of debris without traumatizing the surface.

Technical Specifications

Pore size of PPVF binder, μm ... 5-1,000

Size of abrasive particles, μm ... 2-200

Surface roughness with finest abrasive, not more than μm ... 0.01

Apparent density, kg/m^3 ... 500-800

One kilogram of abrasive material in a PPVF binder filled with silicon carbide costs approximately 25-30 dollars, depending on the degree of its filling with abrasive. The cost of the abrasive material with a diamond filling is determined by the cost of the diamond powder and is 500-750 dollars per kilogram.

Work To Be Done Within Scope of Project

- Development of a technology for large-series production
- Development and fabrication of technologic fittings
- Acquisition of technologic and test equipment
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of abrasive materials in a PPVF binder can be initiated beginning in 1996 with an increase in the volume of production over the course of three years by years:

1996 — 40 tons,

1997 — 80 tons,

1998 — 100 tons.

Funding

The approximate amount of investment required for implementing the work program is 3 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest is the first half of 1998.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05.

Project. Diffuse Silicon Structures

Development of silicon plates and diffuse structures on their basis from BZP silicon for a wide range of items in power electronics for different purposes by means of introduction of basic technologies.

The plates from high-resistance BZP silicon are used in the fabrication of a number of instruments, including detectors, as well as for the fabrication of silicon diffuse structures.

Silicon diffuse structures based on plates of BZP silicon are used in the fabrication of a wide range of items in power electronics for different purposes (including household items).

Technical Specifications

Diameter, mm ... (60, 76, 100)+/-0.5

Thickness (plates, structures), μm ... (210-450)+/-10

Thickness of diffuse layer, μm ... (90-180)+/-15

Remaining parameters — as required by client.

Work To Be Done Within Scope of Project

- Development of a technologic process for the fabrication of plates from high-resistance BZP silicon ensuring the necessary level of surface quality and geometry for the fabrication of silicon diffuse structures (SDS), detectors and other instruments.
- Modernization of existing equipment for purpose of its standardization for the processing of plates with a diameter from 60 to 100 mm.
- Development of a basic technology for the fabrication of SDS for a broad range of items in power electronics from different grades of high-resistance

silicon of different diameter with different requirements on thickness of high- and low-resistance layers.

- Acquisition of modern technologic and control-measuring equipment.
- Preparations for and organization of production.

Times and Volumes

The production of silicon plates from high-resistance BZP silicon can be initiated in 1995 and increased by years (units):

1995 — 50,000 plates and 5,000 SDS

1996 — 500,000 plates and 50,000 SDS

1997 — 1,000,000 plates and 250,000 SDS

1998 — 2,000,000 plates and 500,000 SDS

Funding

The approximate amount of required investment for implementing the work program is 20 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest is the first half of 1998.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05

Project. Silicon Plates

Development of a technology for the fabrication of silicon plates for new-generation VLSI chip memories.

The developed plates satisfy increased requirements on the geometric parameters of such plates (plane and plane-parallel), level of microdefects and surface microcontaminants.

Technical Specifications

Diameter, mm ... (76, 100, 150)+/-0.2

Planeness, μm:

TIR method ... 2, 2, 3

FPD ... 0.8, 0.8, 1.0 in area 15 x 15

Number of particles ... 5, 5, 10 (0.2 μm)

ODU p-type ... < 10

n-type ... < 50

Warping, μm ... 10, 15, 25

Remaining parameters in conformity to SEMI standards

Work To Be Done Within Scope of Project

- Development of a technology for fabrication of silicon plates for a new generation of VLSI chip memories.
- Acquisition of technologic and control-measuring instruments
- Preparations for and organization of production

Times and Volumes

The production of new-generation silicon plates for VLSI chip memories can be initiated in 1995 and increased by years (units):

1995 —100,000;

1996 — 1,000,000;

1997 — 10,000,000;

1998 — 20,000,000

Funding

The approximate amount of investment required for implementing the work program is 30 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1998. The time for full repayment of the loan with interest will be the first half of 1998.

Materials Science Scientific Research Institute, Zelenograd Fax: (095) 530-92-05.

Project. Quartz Glass

The project is for developing a technology for production of quartz glass of exceptional purity and items from it.

Quartz glass of exceptional purity is one of the recent scientific-technical advances and has no analogues. This glass is competitive for use in microelectronics, fiber optic communication lines, active elements of solid-state wave laser gyroscopes, special UV and space optical systems and microprobe optical medical instruments.

Technical Specifications

Total concentration of 18 elements, percent of mass ... $3 \times 10^{-}$

Content of residual hydroxyl groups, percent of mass — 5×10^{-4}

Transmission at wavelength 155 nm, percent — 63

There are no bubbles and stratified nonuniformity.

Approximate price — 200 dollars per kilogram.

Work To Be Done Within Scope of Project

- Development of technology for production of exceptionally pure quartz glass.
- Development and fabrication of technologic fittings.
- Fabrication and acquisition of technologic and control-measuring equipment.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of quartz glass of exceptional purity and items based on it (blanks, plates, units for optical purposes, quartz billets and disks) can be initiated in 1995 and increased by years (kg):

1995 — 200 kg of items of quartz glass of exceptional purity;

1996 —7,000 kg.

Funding

The approximate amount of investment requi d for implementing the work program is 1.6 billion rubles. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997. The time for full repayment of the loan with interest is 1997.

Exceptionally Pure Materials Scientific Research Institute, Zelenograd Fax: (095) 531-70-95

Project. Solar Power Plants (SPP)

Solar cell assemblies of amorphous silicon have high technical characteristics, energy- and resource-conserving manufacture technologies.

SPP are used for supplying power to autonomous objects:

autonomous power supply for household electronic equipment;

power supply for residences;

power supply for ships;

power supply for repeater stations, autonomous control-measuring devices, etc.

The effect from implementation of production is related to a decrease in irreplaceable consumption of natural resources (oil, gas, etc.), ecologic cleanness of the item and satisfaction of the needs of autonomous users for electric power. In leading countries of the world (United States, Germany, Japan) work of this character is being conducted within the framework of a national program.

Technical Specifications

The autonomous power plant consists of an assembly of solar cells, power storage unit and inverter.

Power — 100 W, 500 W, 1 kW, 2 kW, 5 kW Output voltage — 127/220 V

Work To Be Done Within Scope of Project

- Development of a technology for series production of solar power plants, technology of cutting, cassetting and cleaning of substrates, application of contacts, application of transparent conducting oxide, technology for laser scribing, application of p-i-n structure of amorphous silicon and assembly of item
- Development and fabrication of technologic fittings
- Acquisition of technologic equipment: apparatus for cutting glass, conveyor belt thermal stoves for tempering, equipment for applying transparent conducting oxide and equipment for magnetron spraying. It is necessary to develop a line for the preparation of substrates, equipment for applying thick-film contacts, equipment for laser scribing and apparatus for precipitating p-i-n structural amorphous silicon
- Enlargement of plant for metalloceramic instruments, including reconstruction of main building and power facilities
- Metrologic and certification testing
- Organization of warranty servicing and training users

Times and Volumes

The production of SPP can be initiated in 1996.

Volume of production:

1996 — 20,630,000 dollars,

1997 — 31,875,000 dollars.

The profit will be:

1996 — 3,438,000 dollars,

1997 — 6,375,000 dollars.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program is 15 million dollars. The form of funding is an advantageous loan for 1.5 years.

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1998.

Ryazan Plant for the Microelectronics Industry Special Design Bureau, Ryazan Telephone: (0912) 93-01-21, 44-56-43. Fax: (0912) 93-01-21.

Equipment for Production of Electronic Equipment Items

Ye. V. Dmitriyev and G. Kh. Satarov

In order to increase capabilities for the production of electronic equipment items provided for by the Russian State Program for the period 1993-2000 it is necessary to develop a new generation of special technologic equipment in the following directions:

- production of microelectronics items, semiconductor technology and microwave electronics;
- production of electrovacuum instruments; production of radio parts and components; development and production of electronic technology materials;
- control-measuring and test equipment, physical analysis equipment for development and production of electronic equipment items;
- metal processing equipment.

Equipment for Production of Microelectronics Items, Semiconductor Technology and Microwave Electronics

For performance of the tasks set forth in the program it is necessary to develop the principal types of technologic equipment, in particular: for microlithography, application of multilayer and multicomponent metallic layers for creating interconnections and contacts by different methods for three-dimensional liquid processing of plates: assembly, mounting of items on the surface of circuit boards, ion implantation, formation of films of photoresists, diffusion and oxidation of layers, epitaxial buildup of silicon, precipitation of layers from gaseous phase, etc. Provision is made for use of the most progressive technologic methods and design solutions meeting the requirements of production of superlarge integrated circuits and development of a component base to a considerable degree determining the level of the developed equipment. A special place is occupied by automated complexes not only for the production of IC, but also for household equipment and radio apparatus, especially automated technologic lines for the production of microwave ovens, video and audio equipment, small TVs, microcalculators, clocks and medical equipment, as well as equipment and devices for the agroindustrial and fuel-energy complexes.

Principal Technical Specifications of Microelectronics Items

	1994	1995-1997	1998-2000
Minimum size of element, μm	1.25-0.8	0.8-0.5	0.5-0.3
Reproducibility of size of elements, μm	0.05	0.04	0.02
Crystal area, mm	15 x 15	-	20 x 20
Matching accuracy, μm	0.1	0.05	0.03
Additional memory integration level, M	4	16	64
Diameter of processed plates, mm	150	200	300
Introduced defects (size more than 0.1 μm), defects/cm^2	0.01	0.005	0.001

The entire plan can be carried out if the necessary funding is available. The basis is the attained scientific and technical level of development work (for example, under the program for development of cluster equipment and the production of VLSI chips).

Considerable possibilities are afforded by work on establishing a center for submicron technology for microelectronics, micromechanics, nanotechnology and medicine on the basis of the SKN-600 small superconducting synchrotron electron accumulator.

Equipment for Production of Electrovacuum Instruments

Special attention is being devoted to a complex of technologic assembly and test equipment for development work and standard production of kinescopes with a diagonal 42, 45, 63 and 86 mm, as well as a set of equipment

for the production of large-scale microimages of mask templates of color displays and high-clarity household kinescopes, liquid-crystal indicators and gas-discharge indicator screens for TVs with a flat screen and information display systems. It is planned that the working field be increased from 300 x 300 mm (1994) to 600 x 800 mm (1995-2000).

Technologic lines for the assembly and checking of optoelectronic systems with a turnout of not less than 75 percent acceptable items must be set up in order to ensure this work. In addition, in order to increase the technical level of electrovacuum production provision is made for the development of oil-free vacuum pumps, including cryogenic, as well as a new generation of vacuum gage and mass spectrometer equipment.

Equipment for Production of Radio Parts and Radio Components

In this direction it is necessary to develop a series of highly productive sets of equipment for the fabrication of constant nonwire resistances with a productivity up to 200 million units per year, chip resistors — up to 50 million units/year, resistors without lead-outs [quantity not specified] and up to 200 million cylindrical resistors per year. It is necessary to set up automatic lines for the production of membrane units of passive components, lines with the use of the latest technologies for the fabrication of ceramic items and lines for the production of high-voltage units and voltage dividers with a productivity up to 15 million units/year.

Highly productive sets of equipment for the assembly of disk ceramic capacitors and monolithic capacitors with a productivity of each set up to 100 million units/year will be developed.

Provision has been made for developing sets of highly productive equipment for the manufacture of aluminum oxide-electrolytic capacitors of new types.

In general, by the year 2000 the production capability for the fabrication of capacitors must increase by a factor of 1.4.

Equipment for Production of Electronics Technology Materials

In electronics technology the consumer qualities of items are determined to a considerable degree by the characteristics of the material. The program provides for the development of equipment for the fabrication of silicon and gallium arsenide monocrystals with the growing of "pigs" with a diameter up to 150 and 300 mm respectively and equipment also will be developed for the production of semiconductor plates with a diameter up to 300 mm.

The broad use in electronics technology of ferrites and ferrite powders predetermined the development of highly precise automated equipment for their fabrication. In particular, a technologic line will be established for the production of manganese-zinc, nickel-zinc and strontium powders and magnets, which should fully meet needs.

An automated line for the production of quartz resonators, monolithic filters, microoscillators and SAW filters will be established for the mass production of items.

Control-Measuring and Test Equipment. Physical Analysis Equipment for the Development and Production of Electronic Equipment Items

The continuous increase in complexity of newly developed electronic items requires the development of control equipment which is out in front relative to modern requirements. Whereas during the period 1993-1994 the number of outputs of a very large integrated circuit was 256, by the year 2000 it is anticipated that there will be 1,024 outputs with a change in memory volume from 4 to 64 Mbit. Accordingly, the program takes in a broad range of control-measuring instruments (CMI) for the development and production of VLSI and LSI chip memory units, super VLSI chips, digital-to-analog and analog-to-digital converters and linear IC, as well as measurements in the course of their fabrication of the geometric parameters of the plate, phototemplates and topologic structure items. By the year 2000 it will be necessary to measure time lags up to 10 PS, stabilization time up to 0.15 ns, working range up 3,000 mHz, width of element up to 0.15 μm, etc.

The necessary CMI also will be developed for measuring increased electrophysical parameters of semiconductor materials and structures and carrying out their structural and chemical analysis.

Before the year 2000 it is expected that there will be a considerable change in the parameters of microwave instruments, millimeter-range transistors, discrete ultrastable stabistors, quantum electrons items and a full range of components. New CMI are required for all these items.

In the production of electronic equipment items a great influence on the turnout of an acceptable product is exerted by both ambient conditions and by the contamination of technologic media (special gases, liquids, water, air). In this connection the program provides for the development of instruments and methods for monitoring all kinds of contaminants.

The modern production of electronic equipment items must be ecologically clean and requires appropriate ecologic monitoring ranging from the monitoring of radiations to the content of harmful impurities in the form of hybrid gases, compounds containing chlorine, etc. The solution of this exceedingly important problem is provided for in the program by the development of remote monitoring systems corresponding to methods making it possible to determine virtually all harmful substances in the wastes of production in the atmosphere and in industrial effluent.

Metalworking Equipment for the Production of Electronic Equipment Items

The production of electronic equipment items is quite precise work and in many cases requires the use of ultraprecise processing. By the year 2000 the required accuracy of the processing will double (surface cleanness, accuracy of size and configuration) and the productivity of equipment also must be increased.

These problems will be solved when building equipment for ultraprecise lathe processing of parts and processing using multiconfigured lathes, as well as final processing with the use of all kinds of grinding.

Such progressive processing methods as the molding of thin parts from reactive and thermally processed layers, as well as precision thin-sheet processing with waste-free presses, will be further developed.

The production capabilities indicated in the program were determined on the basis of an analysis of needs of the economy for industrial systems and consumer goods and must fully meet the needs of the national economy and defense.

The creation of new facilities provides for the development and introduction of new technologies and new modern technologic equipment, which will make it possible to increase the volumes of production by the year 2000: integrated circuits by a factor of 5.7, semiconductor instruments by a factor of 1.7, resistors by a factor of 1.4, capacitors by a factor of 2.5, kinescopes by a factor of 2.1 and connectors by a factor of 4.4.

Effective state support for the planned programs will make it possible not only to satisfy not only the needs of the country, but also to produce competitive items.

Project. Development of Technologic Equipment Complexes for Production of LSI and VLSI Chips

Development and production of modern equipment making it possible to attain minimum size of elements — 0.5 μm in 1998

Equipment Complexes for Micron and Submicron Lithography in Production of VLSI Chips on Silicon Plates and A^3B^5

	1994-1995	1996-1997	1998-2000
Diameter of processed plates, mm	100-150	100-150	200
Minimum size of element, μm	1-0.8	0.8-0.6	0.5-0.3
Method for obtaining image	projection, FUV		X-ray-graphic, electron beam, ion beam, X-ray image development
Degree of automation	automatic photolithographic lines	automatic microlithography lines with adaptive submicron IP	submicron lithography lines with integrated submicron IP
Class of air purity in processing zone	10	1	1

Equipment Complexes for Obtaining Exceptionally Pure Water

	1994-1995	1996-1997	1998-2000
Resistivity at t = 25°C, Mohm x cm	18	more than 18	more than 18
Content of organic substances (COS), μg/liter	30	10	5
Content of silicic acid, μg/liter	4	1	0.1
Content of bacteria, number/liter	5	1	0.1
Content of microparticles per liter	50	10	1
Size of microparticles, μm	0.1	0.05	0.01
Oxygen content, μg/liter	100	50	20
Dry residue, μg/liter	100	50	20

Complex of Chemical Equipment for Volumetric Liquid Processing of Plates in Production of VLSI Chips With Degree of Integration 1-64 M

	1994-1995	1996-1997	1998-2000
Diameter of processed plates, mm	100-150	150-200	250-300
Cleanness of surface processing of plates, cm^{-2}	0.01	0.005	0.001
Size of introduced particles, μm	from 0.2	from 0.1	from 0.03
Accuracy in maintaining operational parameters, percent	0.5	0.2	0.1
Kinematic productivity not less than, plates/hour	150	150	150

Control-Measuring Equipment

Equipment for monitoring parameters of digital VLSI chips	Monitoring frequency 100 MHz; Number of outputs 256
Equipment for monitoring analog-digital VLSI chips	Audio frequency 4 MHz; Monitoring of parameters: signal-to-noise —100 dB; amplification — 40 dB; error — 5 percent
Equipment for monitoring TV microcircuits	Transmission band 1-10 GHz; Setting error 1 percent; Control error +/-5 percent; Amplification factor 40 dB
Equipment for monitoring transistors, diodes, stabistors, thyristors	Dispersion power 200 W; U_{ke} = 1,000-2,500 V I_{c} = 10 A
Equipment for monitoring parameters of field transistors	Dispersion power 20 W; Gate-source voltage 30-50 V

Technology Microfiltration Outfit for Purification of Aggressive Liquid and Gaseous Media

	1994-1995	1996-1997	1998-2000
Filtered media	acids (other than sulfuric and nitric), alkalis, buffer solutions	acids, alkalis, organic solvents, aggressive gases	acids, alkalis, organic solvents, aggressive media
Temperature, °C	up to 40	up to 100	150-200
Lag threshold, μm	0.2; 0.5; 1.5	0.1; 0.2; 0.45; 0.8; 1; 3; 5; 10; 20	0.001; 0.05; 0.1; 0.4; 0.6; 0.8; 1; 3; 10; 20; 50
Applied Mechanics Scientific Research Institute, Voronezh			

Project. Development of High-Precision Lithographic and Control Equipment Outfit

The outfit consists of 9 items of equipment and is intended for the performance of technologic processes in submicron photolithography and control in the production of super VLSI chips.

Technical Specifications

Minimum topologic size — 0.5 μm.

Precision — +/-0.1 μm.

Productivity — 50 plates/hour.

The cost of an outfit in comparison with foreign analogues is 30-40 percent, which makes them competitive on the world market. Average price — 300,000-400,000 dollars.

Work To Be Done Within Scope of Project

— development of steppers with resolution of 0.8, 0.5 and 0.35 μm;

— development of control instruments with error less than +/-0.05 μm;

— fabrication and testing experimental copies;

— fabrication and experimental use of industrial copies;

— organization of standard production;

— organization of warranty servicing and training of users, setting up of a service center in China.

Funding and Cost Recovery Period

The program will be implemented by stages during the period from 1994 through 1998. The proposed volume of production is 30-40 pieces of equipment per year, beginning in 1997. The required amount of funding is 24.8 million dollars. Form of funding — advantageous loan for 4 years.

The implemented programs will ensure that the costs of the project will be recovered in 1998. The time for full repayment of the loan with interest will be late 1998.

Submikron Scientific-Technical Association Telephone: 536-92-26, 536-48-59

Project. Development of Technology and Equipment for High-Voltage Ion Implantation

The developed automated equipment is for ion-beam alloying, modification and monitoring of the properties of materials. It is characterized by increased reliability, low power consumption, broadened range of current densities (possibility of beam focusing), high accuracy in setting ion energy and dose, high uniformity in alloying and convenience in operation. With respect to the totality of parameters there are no analogues elsewhere in the world. It is intended for solving technologic problems in the formation of submicron structures.

Technical Specifications

Ion energy, keV — 150-1,500 +/-1 percent

Maximum current of beam of ions on target, mA — 0.2 +/- 10 percent

Size of beam on target, mm — 15

Productivity of plates with diameter [not given] — 150 per hour

with dose 10E + 14 — 55

with dose 10E + 15 — 20

Range of controllable doses, μK/cm^2 — 0.002-10,000

Accuracy and uniformity of alloying, percent — not worse than +/-1

Range of masses — 1-130

Type of ions — B, P, As, N, H, Ar, O, Mn

Approximate price — 500,000 dollars

Work To Be Done Within Scope of Project

— development of IL of accelerator at 1,500 keV;

— physical and mathematical modeling of accelerator units;

— working out of design and technologic documentation;

— fabrication of experimental copy of accelerator;

— study of processes of defect formation, activation and redistribution of implanted impurity.

Funding and Cost Recovery Period

The approximate amount of funding for 3 years (beginning of work in first quarter of 1995) — 750,000 dollars.

Form of funding — an advantageous loan.

With production of 3 accelerators a year (beginning in 1996) the total recovery of the investment will be attained by late 1997 with repayment of the loan.

Submikron Scientific Research Institute Telephone 536-15-93, 536-48-59

Project. New Generation of Vacuum Gages and Mass Spectrometers

Development of a complex of vacuum gage and mass spectrometer automated measuring and leak-detecting equipment for the purpose of setting up and introduction of standard production of highly productive technologic equipment, production of integrated circuits, LSI and VLSI chips (spraying, etching, implantation, etc.), as well as electrovacuum instruments of various classes, including microwave, cathode-ray, PUL, etc.

The instrument complex is intended for use in technologic equipment for the production of electronic equipment items and will ensure:

— automation of the process;

— control of the technologic cycle;

— increase in the quality and reliability of items; objectivization of the control of technologic processes and parameters of items; control of the working and residual medium.

Technical Specifications Range of measured pressures — 2×10^{5}-10^{-10} Pa

Error in measuring pressure — from 1 to 3 percent, depending on type of instrument

Range of mass numbers — from 2 to 200 amu

Sensitivity of leak detectors — from 10^{-13} Pa x m^3/s

Automatic switching of ranges, startup and control.

Work To Be Done Within Scope of Project

- Development of designs, circuits, control systems and measurement methods
- Development of sets of pressure compensators
- Fabrication and testing of experimental copies
- Development of standard production technology
- Fabrication of special test equipment and accessories
- Solution of metrologic support problems
- Metrologic testing

Times and Volumes

Beginning of work under program — 1995.

End of work — 1999.

The production of individual types of vacuum gages can be initiated in 1996.

Converters:

1996 — 300;

1997 — 800;

1998 — 1,600;

1999 — 3,000

Vacuum gages:

1997 — 100;

1998 — 500;

1999 — 3,000

Leak detectors:

1997 — 10;

1998 — 50;

1999 — 100

Equipment for measuring partial pressures (special mass spectrometers):

1998 — 10;

1999 — 50

Funding and Cost Recovery Period

The approximate amount of funding necessary for implementing the work program will be 3 billion rubles. Form of funding — appropriations from the state budget. If the stipulated volumes of production are met the total recovery of the investment will be attained in 1999.

High Temperatures Scientific Research Institute imeni Vekshinskiy, Moscow

Project. Test Equipment for Items Exposed to Combined Influence of Pressure, Force and Temperature

- Development of equipment for conducting combined tests of electronic equipment items exposed to temperature, vibration and reduced atmospheric pressure.
- The equipment will make it possible to carry out combined tests of electronic equipment items when using refrigerating units under real conditions of operation and conducting of tests in accordance with the requirements of the standards:

IEC 68-2-39, IEC 68-2-40, IEC 68-2-41, IEC 68-2-50, IEC 68-2-51, IEC 68-2-53

Technical Specifications

Frequency range of mechanical impact — 10-5,000 Hz

Maximum amplitude of accelerations — 1,000 m/s^2

Maximum load — 35 kg

Temperature range — 65-250°C

Relative humidity — 20-95 percent

Pressure range — 10-760 mm Hg

Work To Be Done Within Scope of Project

- Preparation of design documentation
- Fabrication of experimental copies;
- Conducting of metrologic tests;
- Preparations for and organization of production.

Times and Volumes

The production of equipment can be initiated in 1996 and will increase by years;

1996 — 5;

1997 — 10;

1998 — 15;

1999 — 30;

2000 — 100

Funding

The approximate amount of investment required for implementing the program will be 1.5 million dollars.

Form of funding — advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1998.

Time for total repayment of the loan — 1999.

Project. Test Equipment for Items Exposed to Acoustic Pressure

- Development of small acoustic apparatus for testing electronic equipment items.
- The equipment will make possible the conducting of tests for exposure to acoustic pressure.
- The equipment has a considerable advantage in comparison with existing equipment in that it is smaller by a factor of 15-18 and has lower power requirements by a factor of 20, as well as a high acoustic pressure level.

Technical Specifications

Acoustic pressure range — 120-160 dB

Volume of tested items — 100 x 100 x 100 mm

Error in setting acoustic pressure level in accordance with GOST [State Standard] 2057.406 and IEC Standards

Work To Be Done Within Scope of Project

- Preparation of design documentation
- Fabrication of experimental copies
- Conducting of metrologic tests
- Preparations for and organization of production

Times and Volumes

The production of equipment can be initiated in 1996 and will increase by years:

1996 — 15 units;

1997 — 40 units;

1998 — 80 units;

1999 —120 units;

2000 — 200 units

Funding

The approximate amount of investment required for implementing the program will be 800 thousand dollars.

Form of funding — advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1997.

The time for repayment of the loan will be 1999.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

Development of Cluster Equipment for Production of VLSI Chips

Ye. V. Dmitriyev and G. Kh. Satarov

Under market relation conditions the search for means of optimum development of Russian electronic machine building is acquiring special significance for implementing the Russian State Program. A priority task along these lines, with minimum financial expenditures, is to not only maintain, but also considerably raise the technical level of technologic equipment for the production of integrated circuits (IC) and assure the possibility of its rapid reproduction.

The solution of this problem is complicated by a constant decrease in the size of IC elements, increase in their integration and need for developing production with the minimum introduction of defects. With traditional approaches to the organization of production and plants the cost of IC will continuously grow. It is anticipated that the construction of a plant with a productivity

of 10,000 plates per month by the year 2000 will require expenditures up to 2 billion dollars.

The cost of plants for the production of IC can be reduced primarily by a decrease in the volumes of clean rooms while achieving the necessary level of introduced defects.

The so-called submicron IF system, in which special containers are used for the storage and transport of plates, was initially proposed for these purposes. Due to their sealed construction, within a small volume they maintain clean conditions during the transport of plates even in a quite contaminated medium. The submicron IF system (container, device for transfer of cassettes from the container into the technologic apparatus) makes possible a considerable reduction in the volumes of clean rooms because the latter are required only in places of loading of plates into the cassette and their removal from it. The technologic equipment must have submicron IF ports for operating with submicron IF systems.

With appropriate further development work these systems also can be fitted to equipment already operating in production, which is especially important in the modernization of enterprises.

A reduction in the cost of IC also can be facilitated to a considerable degree by the use of cluster equipment. Cluster technology as a radical measure for reducing expenditures on production of VLSI chips was proposed in the late 1980's. This technology provides for the organization of production in technologic microcycles carried out in cluster equipment, integrating successive operations. In such cluster equipment for the most part piece-by-piece processing of plates is performed without their withdrawal into the atmosphere. Within the limits of a definite microcycle cluster equipment makes it possible automatically to develop continuous production within enclosed evacuated volumes or in volumes with a controllable gas medium. As a result the number of operations with the transport of plates between individual pieces of equipment is reduced, the time of storage between operations is lessened and external contamination is reduced.

However, the changeover to the new organization of production requires serious preparations and the working out of special programs.

At the Semicon West-93 conference the Texas Instruments Company has already reported on the results of its program for transforming the production of integrated circuits. Under this program it is proposed that the problem of reducing the cost of a modern enterprise for the production of IC from 1 billion dollars to 30 million dollars with 70 percent use of equipment instead of 30 percent as traditionally the case be solved by the following means: changeover to a piece-by-piece processing of plates; development of automatic control of the entire technologic process; elimination of a great quantity of unfinished production due to the restructuring of production lines, their automation and simulation of processes.

It also was reported that the proposed measures will make it possible to shorten the production cycle from 30-90 to 3 days.

The considered matters in many respects also are characteristic of Russian microelectronics. The proposed ways to solve them also are applicable. This applies, in particular, to the development of new production facilities for the fabrication of universal VLSI by the application of submicron technology. On one hand, without guaranteed investments on the scale of 1 billion dollars there is no enterprise which in the immediate future is capable of establishing a new plant or starting up the corresponding production. On the other hand, existing semiconductor production facilities even in the immediate future will be forced to carry out modernization and revision of the technologic equipment. The use of submicron IF systems in existing and earlier produced equipment can be regarded as the most realistic and desirable.

However, the further development of microelectronics will make it necessary in a short time to develop and then rapidly produce a new generation of special technologic equipment. In accordance with the modern trend in development of semiconductor machine building, this equipment must for the most part be cluster equipment.

Its special features can be summarized as follows:

- Cluster equipment as module-structured equipment includes transport, loading and technologic modules. The modules are replaceable and are combined in conformity to the technologic microcycles. In such form the equipment can be used in the fabrication of VLSI chips or special circuits (special-order or semi-special-order) in the cluster organization of production used in the construction of new plants.
- For the use of cluster equipment in already existing production facilities in which each unit of equipment for the most part performs one technologic operation the cluster apparatus can be combined with only one type of technologic modules and performs one operation. An increase in the output of acceptable items in this case is attributable to the fact that the modules and the apparatus as a whole will have higher technical characteristics.

- The open architecture of cluster equipment will make possible a rapid change in the makeup of the equipment by replacement of only a number of technologic modules and will ensure a substantial decrease in material expenditures in the event of necessary changes in production.
- The combining of cluster equipment into production lines or complexes with their placement in virtually common industrial rooms will make possible the rapid organization of production of special-purpose circuits directly at the enterprises developing the equipment.
- Cluster equipment as completely automated systems ensures the organization of production facilities automated to the highest degree possible.
- In the event that the manufacturing plants have earlier fabricated transport and required technologic modules the cluster equipment can be assembled, checked and delivered to the user in the shortest time possible.
- Development work is now underway on a set of basic transport and a large set of technologic modules meeting the requirements of production of VLSI chips and development work is in progress on the necessary component base and systems for the transport of plates in apparatus and complexes.

In the development of cluster equipment the objective is not only to develop individual pieces of equipment, but also to ensure the possibility of combining them into complexes and automated lines. A linear layout, convenient for individual pieces of equipment and lines, is the most desirable.

The development of cluster equipment to the highest degree ensuring performance of most technologic operations in the production of VLSI chips and adaptable for already existing production facilities is more than just a branch problem.

A special program has been worked out for the development of cluster equipment for the production of VLSI chips, approved on 30 August 1993.

The program provides for the development of competitive equipment, accelerated attainment of a technical level adequate for the production of promising microelectronics items and the routine development and production of circuits and virtually parallel performance of work in the following directions:

— development of basic transport and technologic modules and cluster equipment based on them;

— development of automated production facilities using cluster equipment;

— development of the component base of cluster equipment (gas-vacuum systems, transport devices, control and checking systems, including for checking of airtightness, introduced defects, systems for cleanup of working chambers without exposure to the atmosphere, etc.);

— development of construction materials and technologic fittings;

— development of the production infrastructure for the fabrication, assembly and testing of cluster equipment;

— development of technologic modules for the implementation of promising technologic processes.

In the many-sided performance of the indicated work a possibility is afforded for the development of competitive equipment corresponding to modern requirements.

It must be noted that the development of the technologic modules in conformity to unified design requirements is making possible a considerable reduction in the duplication of development work, involvement of different enterprises in the development of technologic equipment and reduction in the times of development work.

In the program special attention has been devoted to the development of automated complexes, sectors and production facilities.

The work provided for in the program is a logical extension of the integration of the processes involved in the introduction of cluster equipment because every, even autonomously operating cluster apparatus with its full automation is already a "mini" automated sector performing all or part of a technologic microcycle.

This applies, in particular, to the production of semi-special-order circuits based on basic matrix crystals, where a limited number of technologic operations is necessary for the processing of plates. This same complex can be used in the fabrication of special-order universal circuits and be a component part of any automated production with "dry" processing methods.

Work under the program for developing cluster equipment has already proceeded for two years. During this time corresponding requirements on the equipment, design documentation for a wide range of technologic modules and documentation for a number of types of cluster equipment have been worked out. This work has laid the basis for the development of a new generation of special technologic equipment.

Project. Development of Cluster Equipment for Production of VLSI Chips

Development of a set of basic transport and technologic modules of cluster equipment meeting unified technical

specifications satisfying conditions for the production of VLSI chip memory units at the level of 4-16m on plates with a diameter up to 150 mm.

Elemental base for cluster equipment.

Set of specialized cluster equipment for realization of technologic microcycles for the production of VLSI chips.

Automated complexes based on cluster equipment for production of special-order and semi-special-order integrated circuits (minifab).

Technical Specifications

Makeup of equipment:

Modules for: transport, loading of cassettes, atomic purification of semiconductor plates, precipitation of dielectric and metallic layers by gas phase method, thermal precipitation of resist, precipitation of plasmopolymerized layer, precipitation of dielectrics by magnetron spraying, thermal development of resist, etching of dielectric layers, etching of metallic layers, rapid thermal processing.

Cluster equipment for: formation of planarized interlevel insulation, formation of mask layers, formation of mask and etching of functional layer, precipitation of layers of metals by magnetron spraying method, precipitation of dielectric layers by magnetron spraying method.

Types of automated production: automated complex for production of semi-special-order integrated circuits based on basic matrix crystals with use of "dry" processing methods; automated complex for production of special-order integrated circuits using "V-groove" technology; equipment and automated production facilities meeting requirements imposed on processes for the production of VLSI chip memories at a level of 16 M.

Work To Be Done Within Scope of Project

- Preparation of technical and design documents
- Fabrication and testing of experimental copies
- Preparations for and organization of production
- Organization of warranty servicing and training of users
- Startup of production and use of experimental copies by users.

Times and Volumes

The production of the modules can be initiated beginning in 1995; production of units — beginning in 1996; production of automated complexes - beginning in 1997.

Volume of production — in accordance with special orders of user.

Funding

The approximate amount of investment required for implementing the work will be 145 million dollars.

Distribution of investments:

basic transport and technologic modules — 15 million dollars

cluster equipment — 20 million dollars

automated complex for fabrication of semi-special-order circuits — 30 million dollars

automated complex for fabricating special-order circuits using "V-groove" technology — 80 million dollars

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

With the disposition of the experimental copies and production of each equipment item in 10 copies the total recovery of costs will be attained in 1998.

The time of full repayment of the loan with interest is the first half of 1999.

Technical Materials Scientific Research Institute, Moscow Telephone: 535-14-49

Project. Optoelectronic Measuring Modules in Technologic Complexes of "Cluster Equipment" or "Pilot Lines" Type for Checking Parameters of Semiconductor Structures

- Development, manufacture and marketing of self-contained optoelectronic measuring modules for technologic complexes of the "Pilot Lines" type.
- The modules are intended for coupling to technologic equipment by connecting flanges and carrying out initial and ongoing checking for the purpose of rejection of unsuited items in an early stage of production and also for optimizing technologic operations.
- The group of modules includes:

— module for checking internal stresses (σ);

— module for checking lifetime of carriers (τ);

— module for checking oxygen concentration (N);

— module for checking dose of ionic alloying (D).

There are no analogues of the proposed modules.

Technical Specifications

Measurement range for σ (kg/cm^2) — 3-300

Measurement range for τ (s) — 10^{-3} - 10^{-4}

Measurement range for N (cm^{-3}) — 5×10^{16} — 5×10^{18}

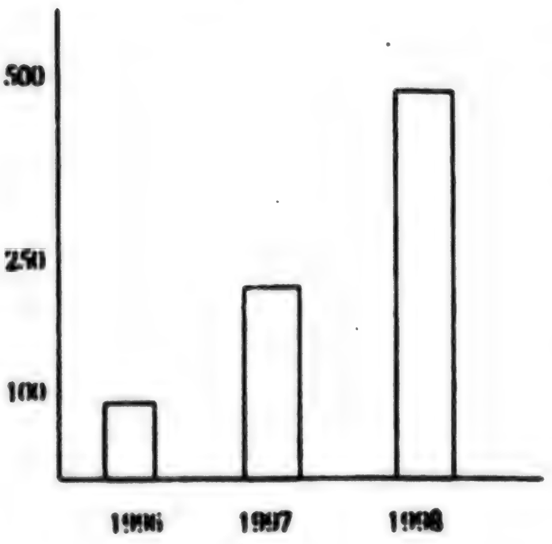
Measurement range for D (cm^{-2}) — 5×10^{11} - 5×10^{15}

Work To Be Done Within Scope of Project

- Development of specialized control-measuring modules
- Development of standard production technology
- Acquisition of technologic and test equipment
- Preparations for and organization of production
- Metrologic and certification testing

Times and Volumes

The production of control-measuring modules can be initiated in 1996 and will increase by years as indicated in the figure (in units).



Funding

The approximate amount of investment required for implementing the work program will be 350,000 dollars. Form of funding — advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the total recovery of the investment will be attained in 1998.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

New Developments in Norm-Setting, Technologic Support of Electronics Industry

V. P. Zagrebelnyy, N. P. Krel, I. G. Lukitsa, V. B. Lysov, M. M. Pimonenko, and N. G. Shata..va

The Russian State Program for the Development of Electronics Technology was worked out taking into account that the norm-setting, technical and metrologic support of all stages in the life cycle of electronic equipment items is a highly important condition for developing and manufacturing products meeting the needs of users in Russia and ensuring their competitiveness on the foreign market.

The development of new economic relations in the country has led to a new state policy in the field of the quality of production, reflected in the RF laws "On Consumer Protection" and "On the Certification of Products and Services," which necessitated a reexamination of the norm-setting - technical support operative in the branch and an improvement of metrologic support.

Standardization

The competitiveness of items is determined not only by their quality, but also to a considerable degree also by their cost. Precisely for this reason the program for the norm-setting, technical support of the life cycle of electronic equipment items included in the Russian State Program for the Development of Electronics Technology constitutes a unified complex of a new generation of fundamental standards and norm-setting documents covering both the technical and economic (under the new management situation) aspects of the activity of enterprises.

The economic aspects are reflected in documents dealing with problems in marketing, manufacturer-consumer relationships, content and standard form of contracts for deliveries, including warranty problems.

The technical aspects include the creation of a scientifically validated system for ensuring quality whose content is determined by economic feasibility and reciprocal interests of the manufacturer and consumer.

The quality assurance system must take in all stages in the life cycle of items from marketing research to operation and therefore the set of documents contains norm-setting, technical support for development work, production, use and recycling of items.

Provision is made for adherence to the following requirements for ensuring competitiveness of items in the development and production stage:

- certification of the quality system employed by the developer;

- working out of technical conditions for the performance of scientific research and design work in accordance with technical requirements for the item, set forth in the OTT standards;
- performance of scientific research and design work in accordance with the technical conditions with allowance for the priority in ensuring quality in the development work stage and economic feasibility;
- testing of production and certification of the quality system employed by the manufacturer;
- fabrication of items in rigorous conformity to the design and technologic documentation adopted by the commission during performance of scientific research and design work;
- certification of items in conformity to prevailing procedures.

The key document in this set of documents is the standard regulating the quality system in the development and production stages.

The OTT standard, incorporated in the set of fundamental standards, must regulate the operational requirements on the level of electronic equipment items; it must be used in developing branch OTT standards for groups and subgroups of items. Technical conditions are being worked out for specific types of items on the basis of branch OTT standards. The technical conditions must contain the operational (user) properties of the items characterizing the requirements of a specific user (client), technical potential of the developer and manufacturer and economic possibilities of the client.

One of the criteria ensuring competitiveness of items is a quality control system for them. In order to enter the foreign market it is necessary that the Russian control system come as close as possible to the international system. For practical purposes this means orientation on IEC standards for specific groups of items. Under conditions of ever-increasing stiff competition relative to imported foreign products the production of items in conformity to recognized international standards and rules is becoming an objective necessity for Russian producers. The matter of the content, structuring and finalizing of delivery documentation has acquired a special role because it is directly related to the possibility of entry of items in the world market.

The new economic relations require a reexamination of the entire content of delivery documents and a changeover to the international system for the preparation of technical conditions, which would make it possible to enter the foreign market with that documentation which also is current within the country. In order to implement this approach provision has been made for a multilevel system of technical conditions (TU) (OTU, group TU, forms of TU and TU with priority of a "lower" document above an "upper" document). These documents define, in particular, the program for tests of items (makeup of the tests, breakdown of the makeup of tests by groups and subgroups, scope of tests, test methods), as well as necessary information on conditions for operation of items. The sections "Technical Requirements" and "Manufacturer's Guarantees" are not included in the TU system. (The technical requirements on items are regulated in the branch OTT standards and it is proposed that warranty matters be set forth in the delivery contracts). The TU provide for the possibility of production of items of several quality categories.

In the system of interrelationships between the manufacturer (supplier) and the user, the most important problem is the principle of defining and guaranteeing warranties. In current practice, in accordance with the "Delivery Conditions," by a warranty is meant a system of responsibility of the manufacturer for the quality of the delivered product.

At present, what is proposed to be meant by a quality guarantee of items is the conveyance of assurance to the user that he will not sustain a loss when acquiring a product from a given manufacturer. This can be achieved, on one hand, by the manufacturer having a quality system, evaluating the effectiveness of this system during testing and certification, carrying out tests of finished items relative to a full set of technical conditions, and on the other hand, by setting an agreed-upon procedure for compensation for expenditures and losses sustained by the user in the case of delivery of items not meeting the technical conditions and the contract. For these purposes the delivery contract stipulates additional requirements on the quality of manufacture of the items, types of compensation for losses and warranty periods, as well as the price for this.

Under the new management conditions the "list price" concept is unrealistic, and the price for an item also is becoming the object of an agreement. Accordingly, it must be included in the contract and the following factors must be included in the contract: expenditures on quality, expenditures on certification of the quality system (certification of production) and items, types and periods of warranties, additional requirements on purpose indices, quality control and the quality system indicated in the contract (if they are present), quality category of items and level of established reliability (in case of necessity).

Work on norm-setting, technical support for the introduction (standardization and unification) of new electronic technologies is being carried out in two direc-

tions: — preparation of scientific and technical documentation for ensuring the development and introduction of progressive technologies for the production of modern electronic equipment items; — preparation of standards ensuring the development of new generations of electronic equipment items meeting the requirements of advanced technologies for the production of electronic equipment (automated assembly and mounting on the surface of boards).

Use in electronics of a new generation of electronic equipment items for surface mounting, developed on the basis of the set of prepared documents, will make possible a considerable reduction in the size and weight characteristics of the equipment (by a factor of 3-6), sharply increase its reliability, economy and speed.

In the technologic operations for the fabrication of electronic equipment items the initial materials and reaction products used, as well as the technologic and auxiliary media, include thousands of different substances, including those harmful and dangerous for man and nature when they enter the environment. The quantity of harmful and dangerous substances ejected into the atmosphere, discharged with sewage and accumulating in the form of wastes, is dependent on the volumes of production, technologic and environmental protection equipment, operations of the service for protecting workers and the environment and many other factors.

The setting of norms and requirements ensuring the total safety of production for man and the environment is a necessary task for the coming years.

Using this norm-setting base, in the immediate future there will be certification of the ecological safety of production facilities and work places at electronics industry enterprises.

Simultaneously with the broad introduction of safe and waste-free technologies, plans call for the working out of norms on the collection, storage, reworking and recycling of production wastes.

The standardization of electronics technology materials is a highly important aspect of implementation of the Russian State Program for the Development of Electronics Technology. One of the problems whose solution will be favored by the supplying of the electronics industry with modern materials is a new quality assurance concept based on assurance of quality during development of the material and preservation of quality during operation. With such an approach the quality of the materials is the result of interaction between suppliers and users, establishing the necessary volume of agreed-upon norms, requirements and rules with respect to materials. A highly important direction in the standardization of electronics technology materials is norm-setting, technical support for their certification, including for correspondence to the requirements of international standards (ASTM, SEMI and others).

In order to accelerate the development and introduction of a cataloguing system in the processes of ordering, inventorying and management of the range of products in the interests of the agencies of state control of industry and the ordering agencies of all forms of ownership, the program for the development of electronics technology provides for the organization of a system for cataloguing the products of the branch, cross-linked to the system for the cataloguing of economic and defense production, and includes the development of the norm-setting, methodical and organizational basis and a set of catalogues oriented on the use of computers. The catalogues are organized in accordance with definite rules making it possible to discriminate important characteristics of the items and to identify them. The program provides for the preparation of norm-setting documents providing basic information and description of special procedures and methods used in the classification and coding of items (including line coding).

Certification

The current stage in the development of the economy of the Western countries is characterized by a qualitative change in attitude toward work on the certification of products and quality systems. By the beginning of 1994, more than 80 percent of the leading European firms and companies registered their quality systems as meeting the requirements of the international standards ISO 9000, and this process is continuing more and more actively, not only in the commercial, but also in the military sphere. Today, work on the certification of production, certifications of its developers and manufacturers, is a highly important element in the armament programs of the NATO countries and the United States.

In the electronics branch, positive work experience has been acquired on international certification of electronic components under the IEC (SC EC IEC). Five electronics industry enterprises and four independent test laboratories have been prepared for certification under international norms; 16 promising types of electronic equipment items have been certified. The total volume of certification tests exceeded 350,000 element-hours. Eleven independent test laboratories, covering a considerable part of the inventory list of products subject to obligatory certification for safety and electromagnetic compatibility, were established and certified in the GOST (State Standard) R certification system for conducting certification tests during 1993-1994 for the purpose of

organizing and optimizing the technical base. The test center of the Elektronstandart Regional Scientific Research Institute also was accredited in this system as a certification agency. The economic activity of a range of enterprises to a considerable degree is determined by foreign contracts, and this trend is broadening. Experience shows that with relatively low prices (for household electronic appliances — by a factor up to 1.5-2, for components — by a factor up to 2.5-5, for materials — silicon plates, pigs — by a factor up to 2.0-2.5) Russian products can be and in very many cases are competitive when a corresponding international certificate is available.

The scales of the problems defined by the program predetermined the need for formulation of a new technical policy and a corresponding organization of work on the certification of electronic products: The need to solve the following problems was taken into account: — creation of the necessary organizational, norm-setting, technical and methodological conditions for broadening the entry of Russian manufacturers in foreign sales markets and protection of the Russian market against the importation of subpar and dangerous products; — optimization of expenditures on making preparations for and conducting certification work; — many-sided solution of the problems involved in the certification of equipment, components and materials; — rendering of practical assistance with certification problems to enterprises.

The solution of the following programs is provided for in the program with allowance for the adopted approach:

1. Harmonization of requirements on the quality of products, methods for supporting it (including direct application of MS ISO 9000 norms), as well as certification criteria and procedures with international norms and rules.

The prepared set of documents (more than 50 fundamental documents) will serve as the norm-setting, methodological basis of a system for quality guarantees and competitiveness of electronic products. Plans call for the many-sided application of the requirements in the documents providing for their use: — in expert evaluation of technical conditions for the development of new types of production; — in monitoring quality and certification of development work (projects) and standard-produced products; — in the certification of developers and manufacturers for the right to receive federal sums and investments for the development of competitive forms of products.

The requirements of the created complex also are oriented for use in concluding contracts with foreign suppliers.

2. Organization and further outfitting of test laboratories of the electronics complex with equipment ensuring direct application of international norms and methods for certification tests of products, including the requirements of the IEC, ISO, CENELEC, ASM, SEMI and other standards.

For the purpose of optimizing expenditures on solution of this problem plans call for the maximum use of the available scientific-technical test potential of enterprises of the electronics complex. Provision also is made for organizing an interbranch center for international certification at the Elektronstandart Regional Scientific Research Institute, interacting with branch test laboratories, on the basis of cooperation for the purpose of establishing a unified certification space. In addition to a strong test base outfitted with all kinds of necessary equipment (including unique apparatus), all the necessary information and data on international and foreign standards, as well legislation of foreign countries (including EC directives) on matters of quality, safety and certification, will be concentrated in the center.

3. Development of international cooperation and bilateral relations with leading foreign certification companies and agencies for the purpose of reciprocal study of the results.

For this purpose, plans call for the further development of work with the TUF Company (Bavaria-Saxony), including the organization of a joint certification center ensuring checking of the certification of reciprocally supplied products in conformity to uniform rules and procedures with the issuance of a single certificate. The experience of earlier work with this company within the scope of a bilateral agreement between TUF and the State Committee for the Defense Industry revealed its high effectiveness.

During 1994-1995 plans call for the broadening of the practice of bilateral agreements with the leading certification agencies in the Western European countries (BSI, VTE and others), and also in Southeast Asia and America.

The implementation of bilateral agreements, including the organization of joint test laboratories and certification agencies, will make it possible to reduce certification expenditures by a factor up to 5-10.

4. Organization of a system for purposeful preparation and training of specialists of Russian enterprises in the quality and certification field, harmonized with international requirements.

Analysis of foreign experience shows that the possession of a quality engineer diploma issued by the ASQC is a necessary condition for hiring in leading American

companies. The need for certified expert certification auditors in the electronics complex alone is now more than 1,500 persons.

5. The development of standard planning solutions and methodologic recommendations for enterprises with respect to preparations for production and the quality system for certification under international norms.

A multiplicative scheme serves as the basis for conducting the work which provides for: — defining uniform groups of products and representative types of items; — implementation of a full work program for its certification for a specific (that is, "reference") enterprise. — reproduction and extension of methodologic development work and design solutions to related types of products and enterprises.

Such an approach will make it possible to ensure preparations for certification in accordance with international production norms and the quality system over the course of 1.5 years (in the preceding period 2-2.5 years) and will be used in the certification of promising types of products developed within the framework of the Russian State Program for the Development of Electronics Technology, including information display devices, microwave equipment, quantoscopes, etc.

Centralized Tests

At present, the State Test Center Elektronstandart Regional Scientific Research Institute is carrying out a fundamentally new approach to the organization of tests: It is set up on the basis of unified, many-sided organization of a system of tests in the chain "materials - electronic equipment items - electronic radio equipment -electronic radio equipment units and assemblies" ensuring solution of problems in the following principal directions:

development, coordination and monitoring implementation of programs for the standardization of requirements and methods for the testing of electronic equipment items and electronic radio equipment on HVF, including methods for evaluating the radiation resistance of electronic equipment items, carrying out research and tests, developing methods and equipment for creating electronic equipment items of a new generation with increased reliability and resistance and ecologically safe for the Russian nuclear and chemical industry;

carrying out independent tests and expert evaluation of the developed and produced Russian electronics and electronic radio technology and materials for electronic equipment items for the purpose of ensuring correspondence of products to international requirements and creation of a unified "test space" based on standardized criteria, methods and procedures ensuring reciprocal recognition of results;

development and introduction of a national system for certification of electronic products harmonized with the results of international standards and ensuring entry of enterprises of the electronics complex into international certification systems;

carrying out independent state expert evaluation of export-oriented and import-replacing products for the purpose of protecting the interests of consumers;

carrying out field tests of copies of products of the electronics complex at climate stations;

introduction of a regional data bank on the quality and reliability of electronics equipment items, household electronic appliances and certified production.

To perform these tasks the State Test Center has an inventory of test and control-measuring equipment making it possible to carry out tests in conformity to the methods provided for in Russian, foreign and international standards (GOST 20.57.406-81, ST IEC 68) and for all practical purposes taking in all types of climatic, mechanical and special technologically operative factors.

The ranges of factors operative during tests are characterized as follows:

for temperature — from -196°C to 350°C

for relative humidity — from normal to 100 percent

for atmospheric pressure — from 10^{-6} mm Hg

for sinusoidal vibration in frequency range — from 20 Hz to 20 kHz to 3 kgs/cm^2

amplitude of accelerations in vibration tests — up to 200

for individual impacts with acceleration — up to 50,000

for linear accelerations — up to 50,000

for acoustic effect with acoustic pressure level — up to 160 dB

In addition, the State Test Center is ou[illegible]th test equipment for carrying out tests for the i[illegible] of such types of specific factors as a salty fog, solar [illegible]ion, fungi, static and dynamic dust, industrial atmosphere, ozone, combined effect of increased (or decreased) temperature, humidity and sinusoidal vibration, etc.

The State Test Center is outfitted with the necessary test equipment for carrying out accelerated tests for the reliability of the principal classes of electronic equipment items, including long-term tests of microelectronics items with an ambient temperature up to 250°C. The Center has the necessary certification methods, ensuring

a reduction in the duration of the tests by a factor up to 10-50.

The State Test Center also is carrying out accelerated tests for evaluating moisture resistance of semiconductor electronic items in plastic housings in a medium of unsaturated water vapor with a temperature up to 140°C, as well as an evaluation of the moisture content in the volume of the semiconductor instruments within the housing and integrated microcircuits with use of the mass spectrometer method. The State Test Center has methods for the accelerated evaluation of longevity indices for most classes of electronic equipment item classes.

In case of necessity when using modern tools for physical-technical analysis and nondestructive checking it is possible to detect the causes and mechanisms of failures of electronic equipment items. Included among such tools there are optical and optoelectronic microscopes, X-Ray - TV equipment, computerized mass spectrometers and an Auger spectrometer.

Project. Norm-Setting and Technical Support for Useful Life of Electronic Equipment Items (EEI)

Development of a unified set of basic standards relative to the quality and reliability of electronic equipment items under the new economic conditions, directed to bringing the requirements on support and quality control of items as close as possible to international practice.

Preparation of norm-setting documents ensuring functioning of a set of basic standards.

Development of norm-setting and technical support for classes (groups) and types of items on basis of the new set of documents and the organization of their introduction.

Technical Specifications

Setting of obligatory requirements on the quality system and sequence of its development and functioning in accordance with ISO 9000.

Testing of production of items and certification of the quality system in accordance with ISO 9000 and foreign standards.

Setting of the sequence for development of electronic equipment items applicable to the new management conditions.

Changeover to international principles for preparing a system of technical conditions; orientation of delivery documents solely in the production stage with the exclusion of operational requirements and warranty matters.

Defining of warranties and types of property responsibility in agreements (contracts) for delivery in interrelationship to price per item.

Introduction of "quality category" concept relating the quality level and item price.

Changeover from the designated (individual) reliability indices to statistical indices.

Full use of international practice in the planning of acceptance tests and rules (IEC Publication 410, IEC standards for electronic equipment items).

Changeover to direct use of IEC Publication 68 — "Test Methods."

Organization of centralized marketing.

Establishment of interrelationships based on partnership and trust.

Application of the requirements in the new set of documents applicable to classes (groups) and types of items.

Implementation of organizational and technical measures for introduction of the new set of documents.

Work To Be Done Within Scope of Project

A set of fundamental standards has been worked out:

— "EEI. Set of Basic Standards. General Provisions."

— "EEI. Requirements on Quality System. General Provisions."

— "EEI. Sequence for Organizing and Startup of Production."

— "EEI. General Technical Requirements."

— "EEI. Test Methods."

— "EEI. Quality control."

— "EEI. Control Plans."

— "EEI. System of Technical Conditions."

— "EEI. System of Manufacturer-Distributor-Consumer Interrelationships."

Documents have been drawn up for ensuring functioning of the set of standards:

— "EEI. Procedures for Conducting Centralized Marketing."

— "EEI. Content and Standard Form of Delivery Contract."

— "EEI. Support and Quality Control for Items of Individual and Small-Series Production."

— "EEI. Use of Statistical Quality Control Methods and Optimization of Acceptance Control, Depending on State of Technologic Process."

— "EEI. Procedures for Calculation of Expenditures on Quality."

Branch standards have been developed for classes (groups) of items:

— general technical specifications for designing of electronic equipment items;

— quality systems in development and production;

— general technical specifications.

A new generation of technical specifications for specific types of items has been developed.

Organizational and technical measures have been carried out at branch enterprises for supporting introduction of the newly prepared branch standards and technical specifications (further outfitting of branch enterprises with technologic equipment, test and measuring devices for developing quality systems; organization of systems for testing production and certification of production).

Times and Volumes

Period of working out set of standards — 1994-1995.

Period of introduction of developed set of standards — 1996-1999.

Working out of branch standards for classes (groups) of items — 1996-1997.

Creation of quality systems at enterprises and working out of technical conditions for specific types of items — 1998-1999.

Funding

The approximate amount of investment required for implementing the work program is 2.9 million dollars. The form of funding is sponsorship.

Cost Recovery Period

Implementation of the project will make it possible to attain the world level in the system for the support of quality and its evaluation with optimum expenditures on this work, as a result of which the user will have maximum assurance that his requirements are met.

ELEKTRONSTANDART Regional Scientific Research Institute

Project. Certification of Production

- Development of a system for certification of electronic equipment with respect to rules, methods and procedures brought into harmony with the requirements of international standards (IEC, ISO, EA).
- The developed system provides for assurance of international recognition of national certificates on the basis of conventions and agreements on cooperation with the leading foreign certifying organizations, as well as the corresponding committees of the IEC and EC.

Work To Be Done Within Scope of Project

— Working out a set of norm-setting, methodological certification documents with allowance for the requirements of the IEC, ISO and EA standards.

— Working out a new generation of fundamental and regulatory documents on promising forms of production, harmonized with international standards. Establishment of an International Center for the Certification of Electronics Products and its accreditation in international and European organizations.

— Further outfitting and accreditation of 22 test laboratories for conducting certification tests.

— Development of a package of methodological materials and standard planning decisions related to certification problems for enterprises in the electronics complex.

— Organization and management of an automated data bank storing information on quality, reliability and certification of products.

— Rendering engineering services to enterprises with respect to preparation of production and quality systems for certification, as well as the signing of contracts for the delivery of products abroad.

— Preparation for certification of more than 100 quality managers and expert certification auditors in accordance with international requirements.

It is planned that implementation of the project will be initiated in 1994 and that it will be completed in 1996.

Funding and Cost Recovery Period

The approximate amount of funding will be: 1994 — 5 billion rubles, 1995 — 25 billion rubles, 1996 — 40 billion rubles.

Form of funding — appropriations from the state budget and investments.

If the stipulated volumes of work are performed, the total recovery of the investment will be attained in 1998.

Project. Karat-128 System for Parametric and Functional Checking of Microprocessor and Matrix LSI Chips

- The system is intended for the parametric and functional checking of microprocessor, matrix and other digital LSI chips in a housing or on a plate.
- The system can be used in the production of digital LSI chips and equipment based on them, as well as in investigating experimental copies of LSI chips.

Technical Specifications

Testing frequency — up to 25 MHz

Number of outputs of tested IC — 128

Time resolution — 0.1 ns

RAM capacity of test sets:

4K test vectors;

1M test vectors (with additional peripheral memory).

128 independent action channels.

128 independent control channels.

Four independent phases in each action channel.

Current supply for controlled LSI chip:

from minus 6 to 14 V / up to 600 mA (three sources);

from minus 6 to 6 V / up to 2.0 A (one source).

Test series processor.

Algorithmic generator.

Logic analyzer.

Four current sources for controllable IC.

Two devices for measuring static parameters.

Autocalibration system.

Contact electronics (driver, comparators, active and passive loads).

Controlling computer of IBM PC/AT-386 type.

Times and Volumes

Production of the system can be initiated in 1996 and will increase by years:

1996 — 10 units;

1997 — 15 units;

1998 — 20 units.

Funding

The approximate amount of appropriations required will be 850 million rubles.

Form of funding — appropriations from the state budget.

Cost Recovery Period

If the stipulated volumes of work are performed the total recovery of expenditures will be attained 4-5 years after equipment production begins.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

Project. International Standardization and Certification

- Organizing a norm-setting base for the certification of Russian electronic equipment items in conformity with the standards of the ISC of the IEC.
- Working out, with Russian authorship, of drafts of IEC standards for the delivery (technical specifications of different classes) of groups of electronic equipment items promising for exportation and for which there is no scientific-technical documentation in the IEC.
- Conducting an active Russian technical policy in the IEC technical committees.
- Establishing a center for international certification of promising types of production in the Russian electronics complex for the purpose of organizing and conducting certification of production and quality systems in conformity to international procedures and norms.

Technical Specifications

Harmonization of the requirements of Russian scientific-technical documentation, including safety and quality control requirements, testing and measuring methods with the requirements of IEC standards.

Increase in the technical level, quality, reliability and competitiveness of Russian electronic equipment items on the domestic and foreign sales markets.

The center must have a complex of testing and control-measuring equipment making it possible to carry out certification tests in conformity to foreign and international standards, recognized by foreign centers and certification organizations, a full set of scientific-technical documentation for production and the necessary number of expert certification auditors for the certification of production and quality systems.

Work To Be Done Within Scope of Project

— Development of Russian State Standards on the basis of direct application of current IEC standards.

— Working out of drafts of IEC standards (technical specifications of different classes) for promising groups of electronic equipment items.

— Further outfitting the test center at the ELEKTRONSTANDART Regional Scientific Research Institute test center with the necessary test and control-measuring equipment for carrying out certification tests for products of the electronics and electronic radio industries and the communication equipment industry.

— Organization of foreign training and certification of expert auditors for the certification of products and quality systems.

— Working out a set of scientific-technical documents ensuring operation of the center and its accreditation in the leading foreign certification systems.

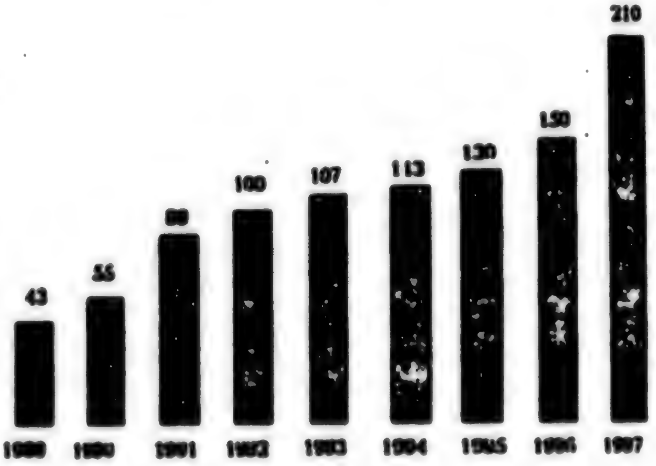
— Performance of specific work for the certification of production and quality systems at the request of the State Committee for the Defense Industry and production enterprises, including in the CIS countries.

Times and Volumes

Bar graph symbolization: — oblique shading: Working out of state standards on basis of direct use of IEC standards. The number of standards approved and put into effect by 1997 must correspond to the number of current IEC standards and those newly introduced (technical specifications of various classes, standards for testing and measuring methods, terms and definitions, parameters and dimensions, etc.).

— grid squares: Working out of drafts of international standards in ISC IEC system for promising groups of electronic equipment items.

Presentation of the drafts of the standards to the RCC of the ISC in 1996.



Дооснащение Центра – 1995 г. (1)

Key: 1. Further outfitting of Center —1995.

Funding and Cost Recovery Period

The approximate amount of investment required for implementing the work program for 1995 will be: for standardization — 100,000 dollars; for the International Certification Center — 7 million dollars.

The total recovery of the investment will be attained 3 years after the Center is put into operation.

ELEKTRONSTANDART Regional Scientific Research Center, St. Petersburg

Metrologic Support for Electronics Industry

I. G. Lukitsa, M. M. Pimonenko, Yu. N. Torgashov, and Ye. A. Yakushenko

Quality control in the entire technologic cycle requires a multisided approach to solution of the problem of metrologic support for establishing criterial parameters for standard technologic operations, detection of the dominant effects arising in technologic operations, optimization of the set of measured parameters and control points in the technologic process, development of flexible con-

trol methods, routinely changeable in dependence on the level of defects in production, development of highly productive and highly precise measuring technology and test equipment, effective calibration methods and devices for calibration, checking and certification.

The State Program stipulates only the key aspects of the supporting directions.

The Metrologic Support Program for the Electronics Industry precisely defines the goals and the periods during which they are to be implemented.

The priority development of microelectronics requires the development of a fundamentally new methodology for the control and testing of items based on advances in mathematical logic and computer technology, the results of research in the field of solid-state physics, surface states and the physics of interaction between fields and matter.

In the years immediately ahead analytic instrument making must be upgraded from the category of a tool for qualitative evaluation of structure, defects and properties into a tool for quantitative measurements supported by reliable methods for confirmation of metrologic characteristics.

The introduction of contactless nondestructive control methods, detection of defective products in the early stages of production, automation of modes and production conditions on the basis of their control is a highly important task in the technology field.

The principal element in metrologic support is the material base, which is divided into two directions: measuring devices and inspection methods.

The variety, technical characteristics and scope of measuring technology are determined by the technical and volumetric indices of production and the creation of a new generation of measuring instruments and methods provides for a modern and sometimes even a somewhat outpacing realization of frontiers relative to the corresponding types of monitored production.

Russian devices and methods for checking finished microelectronics products, inferior to foreign instruments and methods with respect to reliability and capability of the software, are considerably cheaper. In addition, the development of Russian measuring tools will ensure nondependence on imports.

An important breakthrough in the microelectronics field (changeover to an increased degree of integration from 1.2 to 0.8 μm and less) requires the development of a new class of compatible technologic equipment providing monitoring techniques both in the form of measuring devices built into the equipment and in the form of a measuring module built into the technologic production line. The cluster principle for the structuring of equipment for the implementation of specific technologic operations requires the development of a standard series of measuring modules.

The outfitting of pilot lines with Russian rather than foreign control and measuring instruments is a task of primary importance. The Karat-128 system will be developed in 1995. It will make it possible to check VLSI chips with a number of outputs up to 128 with a functioning frequency 25 MHz.

Three types of special LSI chips have been developed on the basis of basic matrix crystals in order to attain high frequency and weight-size characteristics of the system. Provision has been made for special measures for improving cooling, increasing noise immunity and maintaining equipotentiality of the "ground." In order to increase the accuracy and stability of measurements, the power supply for the analog part is from specially developed linear power sources with double stabilization.

Due to use of special microassemblies it was possible to maintain the measurements of the input-output unit at the level of the Karat-64 system, which makes possible its mounting in existing automatic probe devices. The use of these microassemblies also has made it possible to increase the accuracy of measurements due to use of autocalibration of time and amplitude parameters. The cards of the frames for dynamic control were prepared on the basis of multilayer printed circuits (12-14 layers), which ensure a high layout density, reliable transmission of high-frequency signals and an increased noise immunity. Equipment for checking internal stresses in plates (2-300 kg/cm^2 with an error +/-1 kg +/-10 percent of measurement of the parameters), useful life (5×10^{-8}-10^{-3} s with an error 10 percent) and a dose of ion doping (5×10^{11} - 5×10^{15} ions/cm^2 with an error 10 percent) and oxygen concentration (5×10^{16} - 5×10^{18} cm^3 with an error 10 percent), being the first of the developed set of compatible (structurally and with respect to programs) devices for 100 percent contactless checking of semiconductor structures, has been developed and successfully undergone tests at the Elektronstandart Regional Scientific Research Institute. This equipment with respect to its technical parameters, simplicity of servicing, low cost, modular structuring and other characteristics can compete successfully on the international market.

There are also definite successes in the field of developing a stabilized technological table for nanoelectronics, making it possible to use a tunnel (hereafter — atomic force) microscope as a technologic instrument.

The trends in the development of measuring technology have been defined for the following fields:

Replacement of Destructive Checking Methods With Nondestructive Methods

This applies, in particular, to operation-by-operation methods for checking in the microelectronics and semiconductor industries.

On the basis of the expert evaluation of specialists whose principal product is plates, this reduces the cost of production by one-third.

Development of Contactless Methods.

Microwave, optical, laser, holographic, ray and tunnel checking methods are being introduced especially actively into microelectronics. Whereas the checking of geometry (topology, step, slit) has already been mastered, the checking of the electrophysical and the structural state (doping profile, resistance and chemical composition) is being successfully dealt with, the electric parameters of systems based on semiconductor structures for the time being are difficult to deal with. The State Program provides for work on replacing a mechanical probe with electronic and laser probes.

Increase in Productivity

An increase in productivity is attained due to automation of the principal measuring process, by use of a built-in microprocessor or coupling to a central computer through a common-use channel, as well as by organizing multiple work stations.

The dynamics of increase in the productivity of measuring control devices (MCD) in the electronics industry can be evaluated in the following way; the average productivity of MCD in the branch lags considerably behind the average productivity of the developed equipment; reduction in production and reduction of basic industrial funds due to the writing of outmoded MCD has increased the average branch level of outfitting with more productive equipment.

Under modern conditions, when it is possible to employ the advantages of international division of labor, the introduction of the unit-modular principle may give definite advantages ensuring timely revision of measuring equipment.

The experience in using CAMAC, Vector, Q-bus and Eurobus interfaces has enabled branch enterprises to proceed to the development of measuring systems based on the promising bus XVI, being actively introduced by the leading companies in the United States.

Automation

At present, virtually 100 percent of measuring technology development work is based on use of computers and the mechanisms controlling them.

Increase in Reliability

In addition to a low failure rate, the measuring instruments also have metrologic reliability (stability of metrologic characteristics with time). The principal methods for increasing the metrologic reliability of measuring devices are the use of a stable component base and building-in of diagnostic and checking devices in the measuring tools, which will make possible routine correctness of the characteristic dependencies.

Ecological Monitoring Techniques

In the production of EEI, use is made of more than 10,000 types of materials, among which there are many (arsenic, antimony, lead, beryllium, silicone, solvents, etc.) which are classified as toxic. The technologic production processes, involving more than 50,000 different technologic operations, are based on the use of aggressive media, explosive mixtures, UHF and microwave fields, extreme temperatures, high pressure, deep vacuum, strong electric and magnetic fields, etc. Electronic equipment items are subjected to tests for different external factors, such as dust, salty fog, radiation, biologic media, etc. Even electronic hygiene, requiring special sterile conditions, exerts a negative impact on human health, disrupting man's immune system. The need for a substantial increase in the level of monitoring of the parameters of contaminants dictates an increase in the production of the corresponding measuring devices by a factor of 2-3.

The State Program, as well as the programs for ecological control and monitoring, provide for the development of a considerable variety of sensors and measuring devices, among which, for example, it is possible to mention a set of portable optical gas analyzers for CH_4, C_3H_8, C_4H_{10}, CO, CO_2, H_2O, NO_2, NO, and SO_2 with digital readings in the range 0-10, 0-20 percent by volume (error +/-5 percent in the range 0.1-5 percent by volume; +/-10 percent in the range 5-20 percent by volume). The indicated outfit can be used when working in manholes for underground communication lines where harmful gases may be accumulated. The need for the indicated measuring devices is thousands each month. The period for recovery of costs in preparing for production is 6-9 months.

Standard Base of Branch

Assurance of unity and reliability of measurements requires constant improvement in the standard base

of the branch. At the present time two methods are being developed for metrologic oversight of measuring equipment: adherence to state standards through model measuring devices and through a system of standard and control copies, as well as measures of the parameters of electronic equipment items.

The interpenetration and close interaction of electronics and metrology is ensuring development in both these fields. Quantum metrology is today the basis for the reproduction and storage of units of length, voltage, frequency, etc.

The system of standard copies ensures the possibility of conversion of analytic equipment from quality control devices to measuring devices. This is especially important due to the transition of microelectronics to nanoelectronics. The development of standard copies with a line width 1-200 μm and a period 2-400 μm with an error 5 percent, a step height in the range 0.1-30 μm with an error 2 percent, a slit of 0.1-20 μm with an error not more than 1 percent and a thickness of the SiO_2 dielectric layer (50 A — 4 μm) and the Si_3N_4 layer (0.04-0.4 μm) with a testing error of 0-1 percent; the refraction coefficient of the layer is $SiN_x = O_y$ in the range 1.5-2.0 units with an error 0.0005, etc.

The preparation of the indicated sets of standard copies makes it possible to pose the problem of their reciprocal comparison with standard copies in the well-developed countries, thereby ensuring the comparability of methods for evaluating the quality of Russian and foreign products.

The widespread use of computers in measuring and control devices has advanced a new metrologic problem in systems for the control of technologic and test modes: metrologic support of the programmed product. During recent years theoretical approaches have been developed to the problem of verification of algorithms and programs and testing methods have been devised making it possible to evaluate the quality of computer programs.

In virtually all the leading countries international cooperation has made it possible on the basis of quantum effects to create standards for the principal units: meter (stabilized He-Ne laser), volt (Josephson effect) and ohm (Hall effect). The next problem is the replacement of the remaining "artificial" standards — the kilogram standard, for the time being not using fundamental constants, by an "electronic" kilogram.

In the United States the annual expenditures of companies and the government on scientific research work during the last 15 years has doubled (from 85 to 170 billion dollars). Expenditures by the National Institute of Standards and Technology on similar work are being maintained at the level 170 million dollars. More than two-thirds of these expenditures are going for the development of a higher metrologic standard for the country.

The fact that today's volt and ohm standards are based on phenomena discovered in 1962 and 1978 respectively gives evidence of improbable rates of development and a high level of technology primarily in the field of microelectronics and computers.

The electronization of military technology, the economy and the social sphere requires a considerable financial support in the field of metrologic support of the electronics industry.

Project. Metrologic Center for Physicomechanical and Thermotechnical Measurements

The establishment of a center for physicomechanical and thermotechnical measurements, including working standards and highly precise model measuring tools, being the material-technical basis of the metrologic support for tests.

The metrologic center will make it possible to ensure storage, reproduction and transfer units and also to maintain metrologic support for certification tests of electronic components and household electronic equipment.

Technical Specifications

Parameters of motion of measuring complex

Working standard (WS) of unit of acceleration for oscillatory motion

Acceleration range ... 8-2,000 m/s^2

Movement range ... 0.1-10^3 μm

Frequency range ... 0.3-10,000 Hz

Error ... 1.5 percent

WS of unit of acceleration for impact motion

Range of impact accelerations ... 1 x 10^2 - 1 x 10^6 m/s^2

Duration of impact impulse ... 20 μs-20 ms

Error ...0.05 percent

Temperature unit

WS in field of negative temperatures

Range ... 4.2-273.16 K

Error ... 0.3 μK

WS in field of positive temperatures

Range ... 0-1,084°C

Error ... 1.5-2.5°C

WS for temperature in IR range

Range ... 250-1000°C

Error ... 1.5-2.5°C

Model apparatus for certification of thermoanemometers

Range ... up to 5 m/s

Error ... 2 percent

WS for unit of molecular flux in vacuum (for checking leaks and leak detectors)

Range ... 10^{11}-10^{4} Pam,sup>3/s

Error ... 3 percent

Work To Be Done Within Scope of Project

- Preparations for and organization of center for physicomechanical and thermal engineering measurements.
- Outfitting of center for physicomechanical and thermal engineering measurements.
- Metrologic and certification testing of center.
- Development of norm-setting documents on interactions between the center and users.
- Certification of the center by agencies of the State Committee on State Standards for technical competence and right of checking and testing.
- Organization of warranty servicing of clients.

Times and Volumes

Establishment of center 1994-1995.

Operation:

stage I — 1995;

stage II — 1996

Funding

The approximate amount required for implementing the work program will be 1.5 billion rubles.

Form of funding — appropriations from the state budget.

Cost Recovery Period

If the stipulated goals in establishing the center are met the total recovery of the investment will be attained in 1998.

ELEKTRONSTNDART Regional Scientific Research Institute

Project. Standard Copies for Microelectronics

Development of production technology and organization of production of sets of measures for checking, calibration and certification of analytic control devices.

Form of funding

Advantageous loan for 3 years.

Cost Recovery Period

If the stipulated work volumes are met, the total recovery of the investment will be attained in 1997.

The time of full repayment of the loan with interest will be the second half of 1998.

<table>
<tr><th>Name</th><th>Analytic Control Devices</th><th colspan="3">Technical specifications</th><th>Times and volumes of production, sets</th><th>Amount of funding in thousands of dollars</th></tr>
<tr><td>Slit width measure</td><td>Screen electron microscopes with resolution 5-10 nm, with magnification up to 5 x 10^6</td><td colspan="3">Certified characteristic — width of element of slitlike structure; Si-SiO_2 —(Σi); range of certified values 0.1-1,0 μm; certification error 1 percent</td><td>1995 — 50; 1996 — 100; 1997 — 300</td><td>20</td></tr>
<tr><td>Standard copy of relief height of photolithographic step</td><td>Profilometers, microinterferometers, optical microscopes</td><td colspan="3">Nominal values of step height 0.1, 0.3, 3.0, 100, 300 μm. Certification error: 0.1 and 0.3 μm — 5 percent; 3.0, 100, 300 μm —2 percent</td><td>1995 — 200; 1996 — 600; 1997 — 1,000</td><td>250</td></tr>
<tr><td>Standard copy of specific surface resistivity</td><td></td><td colspan="3">Range of nominal values from 0.001 to 10 ohm/square. Certification error 0.5-2 percent, depending on range. Plate range 100 mm. Layer thickness 0.5-5.0 μm. Initial materials: silicides, carbides or nitrides of metals, microcrystalline silicon, doped with antimony, phosphorus, arsenic, doped polysilicon</td><td>1995 — 150; 1996 — 300; 1997 — 500</td><td>250</td></tr>
<tr><td rowspan="7">Standard copy of thickness and refraction index of dielectric layer</td><td rowspan="7">Ellipsometers, microinterferometers, device for measuring thickness and refractive index</td><td>Material of structure layer</td><td>Refractive index</td><td>Layer thickness, μm</td><td rowspan="7">1995 — 100; 1996 —500; 1997 — 800</td><td rowspan="7">200</td></tr>
<tr><td>SiO_2</td><td>1.46</td><td>0.01-4.0</td></tr>
<tr><td>Si_3N_4</td><td>2.0</td><td>0.5-0.4</td></tr>
<tr><td>S_3N_4—SiO_2—Si</td><td></td><td>SiO_2 — fixed, Si_3N_4 0.04-0.4</td></tr>
<tr><td>SiO_2—Si_3N_4—Si</td><td></td><td>Si_3N_4 — fixed; SiO_2 0.04-1.0</td></tr>
<tr><td>SiN_xO_3</td><td>1.5-2.0</td><td>1.0</td></tr>
<tr><td colspan="3">Certification error: for thickness: 10-15 percent; for refraction coefficient: 5-10 percent</td></tr>
</table>

Project. Metrologic Support of Microelectronics Industry

Development of a new generation of highly precise and highly productive control-measuring instruments for development work in the production of integrated microcircuits, including those integrated in production lines.

Technical Specifications

Final checking of finished items		
	1996	2000
Frequency of functional control, MHz	50	100
Number of IC outputs	256	512
IC memory volume, Mbit	16	64
Input current, na	50	1
Bias voltage, mV	100	1
Amplification factor, dB	80	120
Operational checking		
Width of element, μm	0.5	0.1
Thickness of semiconducting layers, μm	0.1-200	0.01-200
Thickness of dielectric layers, nm	3-100	2-100
Size of defects, μm	0.1-0.5	0.05-0.2
Resistivity, ohm x cm	10^{-3}-10^{7}	10^{-4}-10^{10}
Useful life of NNZ, s	10^{-8}-10^{-2}	10^{-9}-10^{-2}
O content in Si, cm^{-3}	10^{17}	10^{16}

Times and Volumes

The production of control-measuring equipment can be initiated in 1996 and will increase by years as production of new types of items is mastered.

Funding

The approximate amount of the required appropriations is 24,500 million rubles.

The form of funding is appropriations from the state budget.

Cost Recovery Period

If the stipulated work volumes are met the total recovery of the requested sums will be attained over 4-5 years of standard production of the equipment.

Project. Outfit for Checking Static Parameters of Low- and Medium-Power Transistors

An outfit for checking the low- and medium-power electric parameters under series and large-scale production conditions during interoperation and final checking.

The outfit can be used independently or as part of a line, including with peripheral devices of the automatic sorting, probe unit and transit chambers types.

Technical Specifications

Return current collector-emitter — 10^{-6}-10^{2} mA

Collector current — 10^{-7}-10 A

Base current — 10^{-8}-1 A

Current transfer factor in circuit with common emitter — 5-20,000

Constant voltage for collector-emitter — 0.1-500 V

Constant voltage for emitter-base — 0.1-500 V

Times and Volumes

The production of the system can be initiated in 1996 and will increase by years:

1996 — 15 units;

1997 — 20 units;

1998 — 25 units.

Funding

The approximate amount of necessary appropriations is 200 million rubles.

Form of funding — appropriations from the state budget.

Cost Recovery Period

If the stipulated volumes of work are performed the total recovery of expenditures will be attained 4 years after production of the outfit begins.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

Project. Climatic Test Equipment

Development and production of equipment for testing of electronic equipment items (EEI) for climatic impacting factors.

The equipment is intended for the testing of different EEI for the impact of heat, cold and temperature change.

The equipment increases productivity by a factor of 3-5 in operations for measuring and checking a number of parameters of highly precise electronic components (relative deviation of resistance, temperature compensation, divider division factor) by reducing the time for stabilizing the temperature of the tests.

Technical Specifications

Temperature range ... -80 - +250°C

Accuracy in maintaining temperature ... 0.2°C

Rate of temperature change ... 1, 3, 5 degrees/s

Work To be Done Within Scope of Project

- Preparation of design documents.
- Fabrication of experimental copies.
- Conducting metrologic tests.
- Preparations for and organization of production.

Times and Volumes

The production of equipment can be initiated in 1996 and increased by years:

1996 — 5 units;

1997 — 20 units;

1998 — 50 units;

1999 — 100 units;

2000 — 150 units.

Funding

Approximate amount of necessary investment for implementing the programmed work is 0.5 million dollars.

The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met, the cost will be recovered in 1997.

The time for full repayment of the loan is 1998.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

Project. Contact Devices for Test Equipment

Development and production of high-temperature and high-frequency contact devices (CD).

The CD are intended for use in test and control-measuring equipment for the testing of integrated microcircuits for the climatic impact, for fault-free operation, longevity and electrothermal conditioning. The CD have substantial advantages in comparison with similar Russian and foreign instruments because they make possible accelerated tests at a temperature up to 250°C and at frequencies up to 1,100 mHz, which considerably reduces test time and affords a great saving.

Technical Specifications

Maximum temperature, °C ... +250

Minimum temperature, °C ... -65

Maximum frequency, mHz ... 100

Capacitance between contacts, pF ... 0.5

Resistance of contact, ohm ... 0.03

Work To be Done Within Scope of Project

- Final working out of a technology for fabricating CD.
- Developing and fabricating press forms for housings and punches for contacts.
- Production of trial consignments of CD.
- Development and fabrication of devices for testing and checking CD.
- Acquisition of technologic and test equipment.
- Preparations for and organization of production.
- Metrologic and certification testing.

Times and Volumes

The production of CD can be initiated in 1996 and will increase by years (thousands of units):

1996 — 100;

1997 — 250;

1998 — 500;

1999—1,000;

2000 — 2,000.

Funding

The approximate amount of necessary investment for implementing the work program is 4.7 million dollars. The form of funding is an advantageous loan for 3 years.

Cost Recovery Period

If the stipulated volumes of production are met the investment will be recovered in 1988. The time for full repayment of the loan with interest is 1999.

Project. Optoelectronic Systems for Monitoring Parameters of Semiconductors in Microelectronics

Development, manufacture and marketing of automated optical scanners for producers of electronic components.

The instruments are intended for conducting initial and ongoing monitoring of the parameters of semiconductor plates and structures for the purpose of rejection of unsuitable items in an early stage of production, as well as for optimizing technological operations.

The outfit includes:

— instrument for measuring mechanical stresses (σ)

— instrument for measuring lifetime of carriers (τ)

— instrument for measuring oxygen concentration (N)

— instrument for measuring dose of ionic doping (D)

All the instruments have a design patented in Russia and are considerably superior to competitive instruments, including due to the following special features:

— modular construction principle;

— use of contactless nondestructive measurements;

— competitive price/productivity ratio

Technical Specifications

Measurement range for σ (kG/cm^2) — 3...300

Measurement range for τ (sec) — $10^{-2}...10^{-8}$

Measurement range for N (cm^{-3} percent) — $5 \times 10^{16}...5 \times 10^{18}$

Measurement range for D (cm^{-2}) — $5 \times 10^{11}...5 \times 10^{15}$

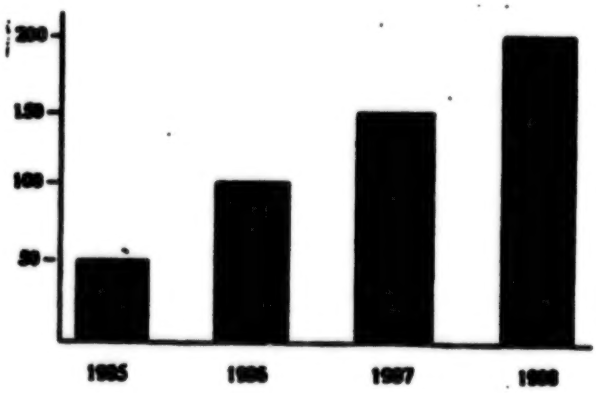
Diameter of plates — up to 150 mm

Work To Be Done Within Scope of Project

- Development of standard production technology
- Development and manufacture of technological instrumentation
- Acquisition of technological and test equipment
- Preparations for and organization of production
- Metrologic and certification testing
- Organization of warranty servicing and training of users

Times and Volumes

The production of the instruments can be initiated in 1995 and increased from year to year (in thousands of units)



Funding

The approximate amount of required investment for implementing the work program is 500,000 dollars.

The form of funding is an advantageous 3-year loan.

Cost Recovery Period

If the stipulated volumes of production are met, total recovery of the investment will be made in 1988.

ELEKTRONSTANDART Regional Scientific Research Institute, St. Petersburg

This is a U.S. Government publication produced by the Foreign Broadcast Information Service (FBIS). Its contents in no way represent the policies, views, or attitudes of the U.S. Government.

— Bracketed indicators before the first sentence of each item describe the way in which the material was processed by FBIS.

— Headlines and all bracketed explanatory notes are supplied by FBIS.

— Personal and place names are rendered in accordance with the decisions of the U.S. Board on Geographic Names as adapted by FBIS. Unverified names in radio and television material appear in parentheses and are spelled phonetically; words and phrases in parentheses preceded by a question mark are unclear in the original and deduced from context.

SUBSCRIPTION INFORMATION

U.S. Government Customers

For a list of FBIS products, to subscribe to an FBIS publication, or to indicate a change of address contact:

FBIS
P.O. Box 2604
Washington, DC 20013-2604
Telephone: (202) 338-6735
FAX: (703) 733-6042

Non-Government Customers

Subscriptions are available from the National Technical Information Service:

NTIS
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4630
FAX: (703) 321-8547

New subscribers should expect a 30-day delay in receipt of the first issue.

END OF

FICHE

DATE FILMED

8 March 96